There are philosophers whose name sounds familiar, but who very few people know in more than a vague sense. And there are philosophers whose footprints are all over the recent history of philosophy, but who themselves have retreated somewhat in the background. Gaston Bachelard (1884-1962) is a bit of both. Without doubt, he was one of the most prominent French philosophers in the first half of the 20th century, who wrote over twenty books, covering domains as diverse as philosophy of science, poetry, art and metaphysics. His ideas profoundly influenced a wide array of authors including Georges Canguilhem, Gilbert Simondon, Roland Barthes, Michel Foucault, Bruno Latour and Pierre Bourdieu. Up until the 1980s, Bachelard’s work was widely read by philosophers, scientists, literary theorists, artists, and even wider audiences and in his public appearances he incarnated one of the most iconic and fascinating icons of a philosopher.

And yet, surprisingly, in recent years the interest in Bachelard’s theoretical oeuvre seems to have somewhat waned. Apart from some recent attempts to revive his thinking, the philosopher’s oeuvre is rarely discussed outside specialist circles, often only available for those able to read French. In contemporary Anglo-Saxon philosophy the legacy of Bachelard seems to consist mainly in his widely known book *Poetics of Space*. While some of Bachelard’s contemporaries, like Georges Canguilhem or Gilbert Simondon (see *Parrhesia*, issue 7), who were profoundly influenced by Bachelard, have been rediscovered, the same has not happened for
Bachelard’s philosophical oeuvre.

This special issue aims to redress the balance and to open up his work beyond a small in-crowd of experts and aficionado’s in France. It aims to stimulate the discovery of new and understudied aspects of Bachelard’s work, including aspects of the intellectual milieu he was working in. Fortunately, for this purpose we were able to rely both on renowned Bachelard specialists, such as Hans-Jörg Rheinberger, Cristina Chimisso and Dominique Lecourt, as well as on a number of younger scholars who are discovering their work in a different intellectual context. At the same time we also want to reassess the value of this oeuvre, which also entails examining the reasons and causes of the relative neglect of Bachelard’s work in recent times. Has it exhausted its possibilities? Does it have intrinsic limitations that have contributed to the eclipse, as some influential, mainly French, philosophers have more or less explicitly suggested?

Thus we want to open a discussion about the legacy of Bachelard’s colourful and multifaceted philosophy, not in order to idolize it, but to rethink the potential relevance of his work for contemporary debates. For while—as with every interesting philosophical oeuvre—there may be good reasons to critically reconsider Bachelard’s thinking, there are no good reasons, we claim, to forget about Bachelard. He remains one of the most fascinating and productive figures of twentieth century thought. Throughout his oeuvre Bachelard has launched provocative and novel ideas on the then newest scientific developments as well as on the elements and dynamics of the poetic imagination, and he addressed important metaphysical subjects such as the philosophy of time. He gave us concepts such as phénoménetechique, surrationalisme, rhythmanalyse, métapoétique, rupture épistémologique, intermatérialisme, or obstacle épistémologique.

To open this debate we have chosen for a twofold approach. On the one hand it traces the manifold afterlives of concepts coined by Bachelard to uncover how his theoretical oeuvre still (explicitly or implicitly) permeates contemporary debates. On the other hand, we revisit concepts and theoretical constellations of Bachelardian origin that have disappeared in the folds of history to see whether and how these concepts could help us rethink contemporary debates in philosophy, science and technology studies, literature theory and cultural studies. Such a twofold approach will allow us both to assess in what way Bachelard’s thought can still be relevant today but also what must be taken into account if one wants to understand what is at stake in contemporary French philosophy.
THE LIFE AND WORK OF BACHELARD

A superficial look at his biography already makes clear that Bachelard never followed standard trajectories. Born on 27 June 1884 in Bar-sur-Aube, at the border between Champagne and Burgundy, he starts his career as a postmaster in his hometown. He performs his military service in telegraphy. This job also brings him to Paris in 1907. At the same time, he starts studying mathematics and natural science. Just before his mobilization for the First World War, he marries Jeanne Rossi, a teacher from his hometown. Bachelard stays for more than four years at the war front. His young wife will die shortly after the war, leaving him a daughter, Suzanne Bachelard. A less well-known fact is that in the fifties and until the eighties, Suzanne Bachelard would also become an important philosopher and epistemologist in her own right, working at the interface of philosophy of science and phenomenology. From the twenties on, the Bachelards will always be together, discussing and influencing each other’s ideas, dividing their time between Paris and Burgundy.

In the years after the Great War, Bachelard teaches physics and chemistry in Bar-sur-Aube. Simultaneously, however, he debarks on a study of philosophy, resulting in his *agrégation* in 1922 and his doctorate in 1927 (*thèses* supervised by Abel Rey and Léon Brunschvicg). Shortly afterwards, aged 46, he takes up a position at the university of Dijon.

Bachelard’s early work is mainly situated within the philosophy of science, and focuses on physics and chemistry. He is especially interested in the recent conceptual revolutions in 20th century physics, relativity and quantum mechanics, and their consequences for science’s epistemology (épistémologie, in the French sense of the term). Apart from detailed studies of specific phases of the history of science, or the early phases of thermodynamics, his most famous books written in the thirties are *Le Nouvel esprit scientifique* (1932) and *La Formation de l’esprit scientifique* (1938). Already in the former it becomes clear that Bachelard’s take on epistemology is not a standard one. Notwithstanding the fact that he clearly knows his classics, Bachelard introduces new elements and a new style in the philosophy of science from the start.

Already in *Le Nouvel esprit scientifique*, for instance, Bachelard denies the classic division of labor and territories between philosophy and the human and cultural sciences with respect to the study of knowledge and science. This denial is not
just a theoretical principle, but influences the way he proceeds, exemplified in the exposition of his cases. Bachelard was not the first to blend the history and the philosophy of science, with a little help from the young sciences of man, in fact he may have been inspired in this by his supervisor Brunschvicg. But the way in which the psychology and pedagogy of science intervene in Bachelard’s philosophical texts about science, is undeniably inspired by Bachelard’s experiences of teaching science to lycéens and makes it very concrete and productive. What is at stake is the mindset of the pupil of science, including all the pre-reflexive elements, the ‘pre-judgements’ that are present in it, and that set obstacles for a real understanding of physical and chemical phenomena. Breaking away from transmitted intuitions about a phenomenon, it has to be understood, i.e. to be captured in the net of new and rigorous concepts. Phenomena, moreover, have to be produced, and this is what happens in an experiment that is foremost a technical manipulation intervening in nature, creating effects—a phénoménotéchnique rather than a phenomenology.

In the 1938 book, *La Formation de l’esprit scientifique*, the notion of ‘epistemological obstacle’ becomes the focus of Bachelard’s attention. Bachelard embarks on a new approach to epistemology that encompasses a ‘psychoanalysis of objective knowledge’ directed towards the description of the imaginary resistances and fixations that stand in the way of the desired real knowledge of the phenomenon that intrigued us in the first place. Images that occupy the mind are such obstacles. For instance, the image that impels us to see the essence of the phenomenon in terms of substances—the element of fire as the substance of heat that is later on in late eighteenth century French chemistry replaced by the fluid called caloric—or the animist image of an organism as directed by an *entelecheia*. Prejudices like these are also associated with such obstacles, such as the belief that general philosophical knowledge should be more fundamental than specialized inquiry, or with verbal obstacles, like seeing a word as the expression of an essence, as in Molière’s famous parody of the *virtus dormitiva* of opium. In *When memory flows into reason* the notion of an epistemological obstacle is revisited by Jan Maršílek in order to stress the relevance of the distinction between an epistemological obstacle in the transition of prescience to science, and a similar but distinct type of obstacle that emerges in mature scientific fields.

The aims and tasks now ascribed to epistemology are twofold: on the one hand analyzing obstacles retarding the development of objective knowledge; on the other, showing how the dialectic, even polemical work of rationality—the application of
rigorous concepts and technical manipulations of phenomena in experiments for instance—counteracts against the forces of the imaginary. This results in a new kind of open and dynamic rationalist view, devoid of any desire to settle down in a philosophical system. Science should not be patronized by philosophical a priori.

But Bachelard does not just advocate a ‘purification’ of scientific knowledge from all pre-scientific practices, denouncing for instance how the persistent temptation for the primal alchemistic intuition impedes the birth of real chemistry. While denouncing substantialist and other images as false origins of knowledge, Bachelard at the same time calls for a study of the imaginary reality of the natural ‘elements’ in their own right. In this view, the four elements of the first so-called philosophies of nature are the basic ingredients for an imaginative conception of the material universe. Bachelard does not connect these elements to nature itself, but to nature as it is imagined and experienced in literary texts invoking natural phenomena, or in daydreams. Which is to say the elements are elements of poetic imagination, that also must be studied independently. The ‘discovery’ of these elements through a kind of epistemic ‘psychoanalysis’ is not only an occasion for the rationalist’s verdict on the obstacles, but also a starting point for a specific study of the imagination, that will take shape in a second series of works in a new genre, the poetics of the imagination. Each of these well-known monographs circle around special clusters of images and metaphors, gathered from Bachelard’s readings of poets and novelists who are drawn to peculiar elements as machines that produce specific types of metaphors. The volume on fire, Psychanalyse du feu, 1938 is almost a companion volume to La Formation, others are devoted to air, water, and earth. Apart from the elements, Bachelard also studies imaginary objects as small and imperceptible as a candlelight (La flamme d’une chandelle, 1961) and as pervasive as space (La Poétique de l’espace, 1957), and phenomena ranging from work (travail), to dream (rêve, reverie), the will (La Terre et les rêveries de la volonté, 1948) and rest (La Terre et les rêveries du repos, 1946).

In the early thirties Bachelard also wrote two intriguing books that can be situated in between his epistemological and poetical works: L’intuition de l’instant (1932) and La dialectique de la durée (1936). Here he advances the intriguing thesis that time is constructed out of singular instants: if anything deserves to be called real and immediate, it is the instant. The temporal continuum is only a temporal construction, an assemblage of instants that are strung together. This is a complete reversal of the, at the time, immensely popular Bergsonian philosophy of duration, where the instantaneous moment was considered as a secondary construction (and a spatialized fixation, for that matter, linked to clock time) abstracted
from the only reality, the continuous flow of duration.

At the beginning of the Second World War, in 1940, Bachelard receives a professorship at the Sorbonne in the history and philosophy of science, as the successor of Abel Rey. During the war, Bachelard also takes up Rey’s presidency of the Institut d’histoire des sciences et des techniques in Paris (later called Institut d’histoire et de philosophie des sciences et des techniques, currently a CNRS group within the framework of Paris-I). At the same time, he is increasingly well-known for his series of books on poetics. While this may add up to a somewhat strange public image, there is no chronological break between the poetical and the epistemological Bachelard. He continues to write three more works on the philosophy of science: Le rationalisme appliqué (1949), L’activité rationaliste de la physique contemporaine (1951), and Le matérialisme rationnel (1953) along with his work on poetics. Evidently, Bachelard’s firm belief that poetic imagination should be separated from scientific thought did not refrain him from working in both fields, never ceasing to express his unrestricted admiration for his two types of heroes: the scientist and the poet.

Eventually, Bachelard retires in 1954, with Georges Canguilhem as his successor at the Sorbonne as well as at the Institut d’histoire et de philosophie des sciences et des techniques. In 1955, Bachelard is elected as a member of the Académie des sciences morales et politiques and he continued writing until his death on 16 October 1962 in Paris. Among his latest works is La Poétique de l’espace (1957), a book that, possibly under the influence also of his daughter, brought him closer to phenomenology. This book would make him posthumously famous outside the French-speaking world. At the end of his life, he was also working on a complete revision of the very first of his ‘psychoanalytic files,’ the one on fire. Suzanne Bachelard posthumously edited these reflections in Fragments d’une poétique du feu (1988), about, among other things, resurrection and the figure of the phoenix, a forgotten mythical persona rising from the ashes of oblivion—who symbolizes our current undertaking...

THE FRENCH RECEPTION OF BACHELARD’S WORK

To fully grasp the importance of Bachelard’s oeuvre, its reception both in France and abroad must be taken into account. Although he was very productive since the end of the 1920s, the first more substantial reception of his work occurs after the Second World War. Apart from occasional brief mentions and references, the
first real articles on his work would only date from the 1950s, for instance by Jean Hyppolite or in Bachelard’s liber amicorum, published in 1957. Of course, this does not mean that his work went unnoticed before: Bachelard was very present and well-known among his colleagues, students and friends—presumably too present to already become an object of study. And, despite the fact that Paris was more inclined towards existenialism in those years, his classes were massively attended, by students, scientists and artists.

It is evident that the initial interest for Bachelard in France was divided between his epistemology and his work on imagination. In the 1960s there were major publications on Bachelard’s views of the imaginary and rêverie. Many of these publications are linked with the French New Criticism or nouvelle critique, with authors such as Roland Barthes, who saw Bachelard as one of their main inspirations. At the same time Bachelard’s writings on historical epistemology and philosophy of science were picked up by a new generation of philosophers and scientists. Authors such as Georges Canguilhem or François Dagognet wrote early studies on his philosophy of science. Similarly, many of his epistemological concepts played a role in the work of Alexandre Koyré, Jean-Toussaint Desanti or Michel Foucault. Foucault, for example, famously placed Bachelard on “the line that separates a philosophy of experience, of sense, and of subject and a philosophy of knowledge, of rationality and of concept” where “one network is that of Sartre and Merleau-Ponty” while the other is “that of Cavaillès, Bachelard and Canguilhem.”

Considering the case of Foucault already makes clear that Bachelard’s influence is not limited to thought about the natural sciences, but that his work proved to be a productive philosophy for the social sciences as well. This is also clear in the work of Gilles-Gaston Granger, student of Bachelard and Cavaillé, who applied insights from Bachelard, combined with structuralism and analytic philosophy, to the philosophy of the social sciences. But equally unexplored is Bachelard’s legacy in fields like sociology, through the work of authors such as Georges Gurvitch and Pierre Bourdieu. The latter’s ‘handbook’ for sociology, has, for instance, been described as “almost exclusively built on Bachelard’s philosophy of science.” Although Bruno Latour himself expressed it as criticism of Bourdieu’s work, this remark does not seem unwarranted. Latour is part of a new generation of Francophone philosophers of science that critically revisit Bachelard’s work. This is especially true for Michel Serres, one of Latour’s main sources of inspiration. Serres started out as a master student of Bachelard, but became very critical from the 1970s onwards. A good example of his critique can be found in the text

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gaston bachelard and contemporary philosophy · 7
The Reformation and the Seven Sins (“La Réforme et les sept péchés”), for the first time translated in this special issue, in which Serres critiques his former tutor’s wish to subject epistemic practices to a thorough purification before they could aspire to be conceived of as science. Similar criticisms and attitudes can be found in the work of Latour and Isabelle Stengers.

Bachelard’s work was also mobilized in a somewhat surprising context: Marxism. Louis Althusser, the new rising star of the left and a student of Bachelard, used Bachelard’s ideas to support his radically new view on Marx’s oeuvre, claiming that there exists a fundamental divide between the early humanist writings of Marx and his later ‘scientific’ work. To define this divide, Althusser invoked a notion from Bachelard’s work: the epistemological break (coupure épistémologique).

Although Bachelard himself never used the notion of ‘break’ (coupure) and only rarely that of ‘rupture,’ the term suddenly came to be conceived of as one of the philosopher’s main concepts. Many authors have, based on more or less the same ‘argument’ (but not for the same reasons) considered Bachelard as a Kuhnian-avant-la-lettre: this observation already suffices to seriously question the significance of analogies of the kind. It is a fact that at least two types of discontinuities play an important role in Bachelard’s own epistemology: the ‘synchronic’ discontinuity between science and common sense (or primary intuitions), and the ‘diachronic’ discontinuity separating prescientific phases of a field of epistemic activity from the scientific stage (from which, in turn, a ‘new scientific mindset’ would eventually emerge). In his contribution about the relation between Bachelard and Althusser, David Maruzzella argues that although the early Althusser was inspired by Bachelard, his philosophy paradoxically became more truly Bachelardian in his later work, when he breaks with his earlier epistemological ambitions in order to pursue a more political project.

In the 1960s and 70s, the work of Bachelard was thus suddenly drawn into the center of the philosophical debates in France, including the larger discussion on Marxism and Structuralism. Althusser took up a leading role in the development of a scientific reformulation and regeneration of Marxism by proposing that Marxism become Structuralism, in the hope that, this way, Structuralism would become Marxism. Other students of Althusser soon took up the notion of coupure, and/or rupture attributed to Bachelard. One of those students was Dominique Lecourt, who wrote his doctoral thesis L’epistemologie historique de Gaston Bachelard under the supervision of Canguilhem, The companion volume Bachelard ou Le jour et la nuit would define the way Bachelard has been read in the 70s and
In “Anti-Bachelardianism in Contemporary French Philosophy” Lecourt himself historically contextualizes and critically reflects on this kind of once dominant reading of Bachelard, and argues that the time has come to develop a more complex understanding of the latter’s significance. Lecourt’s writings have also played an important role in the strict division of Bachelard’s thinking into epistemological work, or ‘Bachelard of the day,’ and his writing on poetical imagination, the ‘Bachelard of the night.’ As a result, many authors who have taken up Bachelard’s work focus only on half of his work, ignoring the other part.

In recent years, however, we can witness a countermovement in France. A range of authors has refused to reduce Bachelard to either an epistemologist or an aesthetic theorist highlighting instead the metaphysical and philosophical theories that fuel his thinking in both domains. This has been one of the main merits of the work of Jean-Jacques Wunenburger, linked with the International Gaston Bachelard Association (Association Internationale Gaston Bachelard, A.I.G.B), founded in 1984. From 1998 onwards, the association has also been publishing a range of Cahiers Gaston Bachelard, dealing with specific topics ranging from Bachelard’s relation to German philosophy, to the influence of psychoanalysis on his work. One of the most productive discussions in this context has been a revived interest in Bachelard’s metaphysically oriented works, such as L’intuition de l’instant and Dialectique de la durée. Bachelard’s philosophy of time influences both his subsequent writings on epistemology and on imagination. Entering into a polemical debate with the work of Henri Bergson, Bachelard develops a time that is dialectical and discontinuous. The fierceness of his tone, however, raises questions to what extent his own work is indebted to Bergson. In “Towards an Interdisciplinary Anthropology?” Johannes D.M. Schick focuses on the similarities in the thinking of Bachelard and Bergson, and Georges Simondon as a figure who allows for an escape from the theoretical deadlock between the two contemporaries. In “Becoming Rhythm,” Jonas Rutgeerts proposes a more nuanced understanding of the polemical discussion between Bergson and Bachelard by exploring the importance of the notion of rhythm in both philosophical systems.

Another of Bachelard’s notions that blurs the distinction between science and art—day and night—is surrationalism. Bachelard launched the term in a text of 1936, and it pops up in later texts, such as in his Philosophie du non (1940). Next to its obvious reference to surrealism (a movement Bachelard had frequented for some years), the term is also closely linked to Bachelard’s idea of an ‘open ratio-

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gaston bachelard and contemporary philosophy · 9
nalism.’ In Bachelard’s view, the rationality of science is a dynamic and open one, operating in the modus of a permanent rectification of concepts and theories. Such a dynamic openness can be found both in his work on science and in that of poetics. The thesis has been taken up again in a recent book by Zbigniew Kotowicz, who argues that for Bachelard philosophy “is not the business of contemplating reality but of surpassing it.” Kotowicz also provides an English translation of the text on surrationalism as an appendix to his first chapter. Massimiliano Simons’ text “Surrationalism after Bachelard” takes up this notion in order to re-read the relation between Bachelard and Michel Serres, with a focus on the latter’s early project of writing about the *nouveau nouvel esprit scientifique*, an attempt to update Bachelard through new scientific findings in information theory and molecular biology. Through this attempted update Serres would come to one of his later criticisms of Bachelard. Simons shows that, despite Serres’ self-proclaimed turn away from Bachelard, there are still significant parallels between Serres and his predecessor.

**THE ANGLO-SAXON RECEPTION OF HIS WORK**

The reception of Bachelard’s work abroad, especially in the Anglo-Saxon context is probably even more capricious than the French one. Bachelard himself has hardly published anything in English, except for a text in a *Festschrift* for Albert Einstein. The Anglo-Saxon world therefore had to rely on secondary works and translations, both profoundly coloring its reception.

One of the elements that heavily influenced the Bachelard reception in the Anglo-Saxon world is the fact that, while all the major works on poetics and imagination have been translated early on, Bachelard’s epistemological works have only slowly and selectively found their way to Anglophone audiences. The first translations of *The Poetics of Space* and *The Psychoanalysis of Fire* (both in 1964) were followed by *The Philosophy of No*, dealing with epistemology, in 1968. In 1981, inspired by its director Joanne H. Stroud, the Dallas Institute of Humanities and Culture contracted a project with the editor José Corti to translate all of Bachelard’s books on the imagination. This resulted in eight additional translations, such as *Air and Dreams: An Essay on the Imagination of Movement* (1988), *The Flame of a Candle* (1989) and *The Right to Dream* (1990). During this period, no epistemological works were translated, except for *The New Scientific Spirit*, appearing in 1988.
Only more recently, a few new translations have been published, such as *The Formation of the Scientific Mind* (2002), *Intuition of the Instant* (2013), and *Dialectic of Duration* (2018). However, several of Bachelard’s major books in philosophy of science are to this date not yet available for international audiences. In the Anglo-Saxon context, this situation has contributed to an image of his work as only or largely dealing with imagination and literature. Taking at least a small step to overcome this lacuna, this special issue includes the translation of the first chapter of *Intuitions Atomistiques* (1933): “The Metaphysics of Dust” in which Bachelard analyses the various shapes of dust and their relation to a philosophy of atomism. Written in 1933, in between *L’Intuition de l’instant* and *La Dialectique de la durée*, Bachelard’s essay on atomism can be seen as one of his first ventures into metaphysics. At the same time, however, it also prefigures Bachelard’s passion for poetic imagery. Despite the fact that Bachelard condemns the “traditional principles of atomism” for being essentialist, i.e. ascribing essential characteristics to the atoms, and advocates to replace this essentialist vision with a mathematical one, in which the atoms derive their properties from their constellation, “The Metaphysics of Dust” still displays a great interest in all those traditional versions of atomism. Rather than simply brushing over obsolete ideas, Bachelard describes the image of dust in great detail. Here, we can already witness the germs of his fascination for the ‘natural elements’ to which he will devote several books.

In the Anglo-Saxon secondary literature, a second bias can be pointed at. It has, for instance, been proven crucial that one of the first books on Bachelard available in English was precisely a translation of the work of Dominique Lecourt. Together with early translations of Althusser’s own work, such as *For Marx* (in 1969) and *Reading Capital* (in 1970), Lecourt’s book has contributed the incorrect view that Bachelard himself was a Marxist-inspired philosopher of science and even led some to claim that Bachelard’s work aimed to “portray scientists as a proletariat exploited by bourgeois philosophers who held them accountable to standards not of their own making.”

A similar bias exists within the field of Science and Technology Studies (STS), due to the fact that many of Latour’s books were available in English long before those of Bachelard. In *Laboratory Life* (1979), written together with Steve Woolgar, Latour introduces the notion of *phénoménotechnique* to argue that within scientific practices it “is not simply that phenomena depend on certain material instrumentation; rather, the phenomena are thoroughly constituted by the material setting of the laboratory.” According to some, the result was an incorrect “association,
made by social constructivists, between phenomenotechnique and their own claims concerning the socially determined character of scientific practices.” In “Gaston Bachelard’s Philosophy of Science: Between Project and Practice” Bas de Boer looks at contemporary debates into science studies through the lens of phenomenotechnique. With Bachelard, de Boer stresses that science is neither completely ahistorical and rational, nor completely situated and constructed. Rather, science is the particular execution of a universal project.

In light of this, Bachelard’s work has been taken up by a range of scholars under the banner of ‘historical epistemology,’ for instance in the work of Ian Hacking or Hans-Jörg Rheinberger. The notion of phenomenotechnique is one of the central Bachelardian concepts in this tradition and demonstrates an interesting tension between historical epistemologists and STS. Whereas the first group tends to be positive about Bachelard, the second has become quite critical, although both groups do not necessarily diverge substantially about the positions they defend. Thus it remains an open question to what extent there is an actual conflict between Bachelard and fields such as ‘science studies’ or to what extent they could enrich one another.

Within STS, however, the notion of phenomenotechnique has also been linked to another concept, that of ‘technoscience,’ often falsely attributed to Bachelard. The concept of ‘technoscience’ itself was originally coined by Gilbert Hottois in the 1970s, but was later popularized by authors such as Jean-François Lyotard and Latour, both partly inspired by Bachelard. Technoscience refers to how science is always linked with applications and with broader societal goals, such as efficiency and performativity. Bachelard himself never used the concept, but it approximates some of his ideas related to phenomenotechnique and his ‘applied rationalism.’ On the one hand, the role of concepts and theories within the contemporary sciences is highlighted, on the other hand, concepts and theories can no longer be clearly demarcated from technical applications and conditions.

In “The new axiomatic method: Bachelard on the meaning and deformation of concepts,” Boris Demarest stresses that one must be weary of all-too facile equations such as of phenomenotechnique with technoscience. Instead, Demarest argues that for Bachelard phenomenotechnique must be linked first of all to concept formation, which must be understood in connection with David Hilbert’s axiomatic method. For Demarest, contemporary re-readings of notions such as phenomenotechnique ought to be subjected to a substantial dose of skepticism.
WHAT CAN WE LEARN FROM BACHELARD TODAY?

Given this state of the art, numerous questions can be raised about the influences, interactions and relations of Bachelard and his contemporaries, subsequent generations, and broader scientific and cultural developments. As with Bergson, one may wonder how Bachelard’s philosophy relates to classic authors such as Descartes, Spinoza, Hegel or Nietzsche, all of whom seem to play a role in Bachelard’s work and are occasionally referred to by him. Similar questions can be raised about interactions with his contemporaries and immediate predecessors or successors, such as Léon Brunschvicg, Emile Meyerson, Jean Cavaillès, Ferdinand Gonseth or Hélène Metzger. And how to estimate Bachelard’s use of then recent scientific domains such as quantum mechanics and the theory of relativity? His ‘new scientific spirit’ was nothing else than an attempt to grasp the novelty of these new sciences. But how to map his interpretation of these novel sciences among the many possible (and actual) interpretations that have been given? What about his comments on the scientific and philosophical views of, for example, Einstein or Louis de Broglie? What about his views on earlier phases of sciences, e.g. on sciences that already took their great leap forward before the advent of the so-called new scientific spirit? Chemistry, for instance, was crucial in the education of Bachelard and many of his contemporaries, such as Meyerson, Metzger and Duhem, or more recently, François Dagognet, Isabelle Stengers and Bernadette Bensaude-Vincent.36

Then again, this is not a plea to just shift the focus back to the context of epistemology: similar questions must be asked about Bachelard’s attitude towards psychoanalysis, existentialism or phenomenology. It is important even to look beyond the field of philosophy proper, and review Bachelard’s relations with artists and scientist. In his article, Rheinberger attempts to analyze one of those ‘external relations,’ as he explores the fruitful collaboration between the French philosopher and the relatively unknown engraver Albert Flocon. This will hopefully stimulate a contemporary audience to not only consider Bachelard’s ‘new scientific spirit’ in relation to the cultural, philosophical and scientific developments of his own time, but also in relation to the sciences and cultures as they are happening, in our time and into the future.
NOTES

1. This special issue and several of its contributions result from a bilingual conference entitled ‘Bachelard Today/Bachelard Aujourd’hui: Gaston Bachelard and Contemporary Philosophy,’ held at the Institute of Philosophy (Hoger Instituut voor Wijsbegeerte, HIW) at the KU Leuven, Belgium at 24 and 25 April 2017. The contributors were Francesco Carpanini (University of Bologna), Cristina Chimisso (Open University), Paul Cortois (KU Leuven), Bas De Boer (University of Twente), Boris Demarest (University of Amsterdam), Lucie Fabry (ENS), Gilles Hieronimus (Université de Lyon III), Julien Lamy (Université de Lyon III), Jan Maršálek (Institute of Philosophy of the Academy of Sciences of the Czech Republic), David Maruzzella (DePaul University), Julien Pieron (Université de Liège), Hans-Jörg Rheinberger (Max Planck Institute for the History of Science), Jonas Rutgeerts (KU Leuven), Ilaria Salonna (University of Warsaw), Johannes Schick (a.r.t.e.s Graduate School for the Humanities Cologne), Massimiliano Simons (KU Leuven) and David Webb (Staffordshire University). An additional word of thanks goes to Florence Caeymaex (Université de Liège), Jens De Vleminck (University of Ghent), Darian Meacham (Maastricht University), Jonathan Sholl (Aarhus University), Getrudis Van de Vijver (University of Ghent), Maarten Van Dyck (University of Ghent) and Hanna Vandenbussche (KU Leuven) for contributing to the organization of the conference. Finally, we wish to thank the Institute of Philosophy, KU Leuven and the Flanders Research Foundations (FWO) for their financial support.


4. I.e., as ‘history and philosophy of science(s),’ rather than as a general theory of knowledge.

5. One specific ‘classic’ that has a major influence on Bachelard’s work was his teacher Léon Brunschvicg (1869-1945). Recently scholars seem to come to agree that Bachelard was much more influenced by his master than was earlier thought, See e.g. Cristina Chimisso, “From phenomenology to phenomenotechnique” in Stud. Hist. Phil. Sci 39(2008), p. 384-392, §2.

6. Bachelard’s daughter Suzanne is at that moment one of the prominent pupils of his friend Jean Cavaillès, the mathematical philosopher and Resistance hero who was killed in 1944: among these pupils are such fellow epistemologists and philosophers of science as Gilles Gaston Granger, Jean-Toussaint Desanti, Tran Duc Thao, and Jules Vuillemin. A select club of Bachelard’s and Cavaillès’ students and friends (notably also Albert Lautman, killed in 1943, aged 36, and posthumously one of the important inspiring figures for Gilles Deleuze) has been involved in far-reaching clandestine activities at that time.

7. Canguilhem was himself succeeded there by Suzanne Bachelard in 1972.


25. This in contrast, for instance, to the work of other epistemologists such as Emile Meyerson and Pierre Duhem, whose work is more fully translated, often from an early date onwards. See Emile Meyerson, *Identity and Reality*, translated by Kate Loewenberg. London: Allen & Unwin Ltd., 1930; Pierre Duhem, *The Aim and Structure of Physical Theory*, translated by P.F. Wiener. Princeton:


27. See Lecourt, *Marxism and Epistemology*.


31. The notion of phenomenotechnique indeed addresses a broader issue than mere social constructivism, namely that of the role of intervention and construction in science. Hans Radder even calls this the “Bachelardian challenge,” referring to “the question how scientific knowledge can be about a human-independent reality, if this reality is so thoroughly dependent on human work.” See Hans Radder, “Science, realization and reality: the fundamental issues,” *Studies in History and Philosophy of Science* 24, no. 3 (1993): 328. Social constructivism is merely one possible reply to this question, namely by negating the idea that such an access to a human-independent reality is possible. More options are available, and the notion of phenomenotechnique precisely forces us to examine them.


If everyday experience did not provide us with the many and varied phenomena of dust, it can be assumed that atomism might not have received such a ready following from philosophers and that it might not have enjoyed such an easily renewed fate. Without this special experience, atomism could only have been conceived as a highly speculative scholarly doctrine in which the idea’s initial venture was not justified by any observation.

By contrast, based solely on the existence of dust, atomism has been able to receive, from the very beginning, an intuitive base at once permanent and rich in suggestions. These initial suggestions evidently serve to explain atomism’s historical as well as its pedagogical success and, here in particular, philosophy benefits from bringing together pedagogical and historical elements. From this straightforward pedagogical perspective, I will try, in a few pages, to study atomism’s simplest image, one that is durable precisely because it is simple and rudimentary. Charles Adam, for example, did not hesitate to see Descartes’s younger days as the source of some of his guiding intuitions. As he points out, because Descartes lived in the country, he was able to take note of several curious traits of nature. Among such natural lessons, Charles Adam specifically includes familiarity with
phenomena like will-o’-the-wisp, dust, and whirlwinds. In fact, it should be noted that a whirlwind is a rarer occurrence than one might think and that many talk about it who have not had the opportunity to observe it. One must have seen the dust on the road, at the bottom of a ravine, caught up and lifted by a favorable wind to understand what is at once structured and free, light and delicate, in the swirls of a whirlwind. The best-made whirlwinds are the smallest ones. They stay within a wheel path. They can actually rotate around themselves like a humming top. More commonly observed river eddies give us a far cruder image than a whirlwind drawn by dust. Water only gives us a lightly engraved design; dust gives it in full three-dimensional relief.

Whatever one may think of the importance attributed by Charles Adam to these first material images of Cartesianism, there is no doubt that one finds, in what is most often a radically materialist atomistic literature, numerous quotations pertaining to the phenomena of dust. It therefore seems astonishing that Lasswitz does not include in his otherwise detailed index anything that recalls ideas of dust, powder, or pulverization. These concepts certainly deserve to be given priority over amber, mercury, and smoke—which Lasswitz did include.

Following these general remarks, let us attempt to appreciate the importance of dust for the teaching of atomism.

We can start by presenting something of a negative proof of the intuitive value of such a phenomenon. All it takes is to imagine how our intuition would be affected by a world of well-defined solids, a world of objects whose individuality would be strongly and clearly related to size, as is the case, for example, for all animated bodies. For greater clarity, let us complete our assumptions by setting up a world where these defined and individualized objects have sizes that extend over a rather limited range, thus containing neither very large nor very small objects. We understand right away that in such a world material division would be seen solely as an artificial process. Intuitively speaking, we could shatter, but we could not analyze. Of course, an advanced science might succeed in transferring the principle of individuality elsewhere, agreeing, for example to analyze a solid geometrically. But then geometrical analysis and the partition of the real would no longer be synchronous. The former, bearing the mark of ideality, would belong to the world of possibility pure and simple. Nothing real would correspond to it.
Now let us change scientific utopias. Instead of a world of well-defined geometric solids, let us imagine a world of pasty objects, such as, for example, a universe briefly considered by Mach, that is a little too hot, where everything flattens out, where forms inhabited by essential fluidity are nothing more than moments of development. This time, contrary to what happens in our first hypothesis, division is now the law. Every object dissolves, loses its shape, and is endlessly segmented. The ideal pattern is flowing water that divides as easily as it reassembles, thus illuminating a perfect reciprocity of analysis and synthesis. Faced with such a scene, how could we posit the idea of an *indivisible element*? The only way would be to contradict concrete experience and generally observable evidence. And here again our means of separating the real and the possible would be deeply perturbed. Yet all we did was put forth a poor, simple assumption as we constituted our scientific utopia, only to see that assumption modify all that is possible and, like a reagent, precipitate a brand-new reality! In a world of pastes and liquids, it would seem that the possible is, I daresay, more real than immediate reality. For the possible is now everything in the process of becoming, now rendered more clearly by its increased activity. By contrast, reality is nothing more than an ephemeral and accidental form, an individual frame in a film. By underscoring through thought the fluidity of solid bodies, we might have believed that we affected only a material quality, but we realize, in the end, that we have perturbed even the most fundamental categories and forms of our knowledge since we enter into an extraordinary world where time finally dominates space.

So, in a way, we can frame the real world with two hypothetical worlds that are equally easy to imagine: the first where solidity is everything, the second where solidity is nothing. But one can see right away that, in these two utopian worlds, atomism does not encounter the elements of its first teachings since, in one of the hypotheses, division of matter would be an anomaly and, in the other, a rule to be endlessly applied. Realistic atomism is indeed dependent on a direct intuition of material diversity. I have tried to show elsewhere how difficult it is for scientific thought to uncover categories and order within immediate diversity. In some ways this diversity must be seen as irreducible if we want to preserve atomism’s full value of explanation. That is why, as we have just seen, atomism immediately loses all meaning when a profound, hypothetical cause of uniformity is slipped into the real. The concept of dust, halfway between that of a solid and a liquid, will, by contrast, furnish a sufficiently mixed proof on which to base atomism.
Of course, as I indicated earlier, this is but a negative argument, one that tends to underscore atomistic philosophy’s dependence on the very general empirical conditions in which thought is developed. I must now begin a more positive examination and take things as they are, not only in their multiple forms but also in their frequent deformations.

III

The thesis that I will defend, at once general and complex, goes against Bergsonian theory in that it sets out to complete a proposition that, in its very essence, should not require completion. Indeed, Bergson undertook to assimilate our fundamental habits of thought to our everyday experience of solids. According to him, everything that is framed, categorical, and conceptual in human intelligence stems from the geometric aspects of a world of solids. Our experience of solids leads, in a way, to solidifying our actions. Objectivity as stability is thus related to the solidity of objects. Only what is solid is thought to hold a sufficient number of features strongly enough to represent and maintain the “dotted line” that outlines our possible action. In the face of the simple sketch of our actions thus geometrized through our experience of solidity, all other natural phenomena come across as irrational.

Bergson has surely uncovered in this instance a dominant feature of understanding. In particular, everything that is exchanged socially is expressed in the language of solidity. Similarly, a substantive noun is, in effect, defined from the outside. It can be placed in any sentence the way a solid is placed in any location. In its logical form, language thus corresponds to a geometry of the well-defined solid. But here is where Bergson’s thesis needs to be extended. If the initial orientation of intellectual and verbal organization really means the immediate utilization of objects of experience, how do we delete equally characteristic elements from that everyday experience? How do we overlook flowing water, silent oil, sticky honey, paste, mud, clay, powder, and dust? To be sure, all these things find their way back to solidity, but they also contradict certain essential characteristics of solids. Let us not object that solidity is the rule and that liquid or dust are exceptions. For it is quite remarkable that, as principles of explanation, clear and flagrant exceptions carry the same quotient of conviction as do general characteristics—a strange dialectic this, one that thrives on oppositions yet rejects from the bases of its explanation only those elements that are mixed and mingled! Even from a scientific perspective, are the most frequent themes of an explanation not the perfect,
undeformed solid and the perfect liquid without viscosity, in other words, two features that are frankly exceptional? One has to arrive at a very advanced physics to find any appeal in the study of mesomorphic states. But from a psychological point of view—the only one that interests me at the moment—these studies of intermediate states are analytical; they are expressed with the help of supposably simple primary states. At the same time, states taken to be primary—solids, liquids, paste, or dust—do not raise questions; they provide the direct answers of intuition. They are elements of naïve explanation. As a result, it is all of nature that teaches us, and understanding enters through all our senses. Thus, we must speak of a kinetic intelligence alongside the geometric intelligence given primacy by Bergson. We must even add a materialist intelligence. Ultimately, we must recognize that our language is, if not by its nouns at least by its verbs, as tactile as it is visual. Henceforth a more objective intuition of matter will lead to what is, from many points of view, a broader Bergsonism.

In my view, a deformation, even when visual, is not understood as a mere loss of forms, for as soon as we consider how our actions are accomplished, we realize that the deformation we impose on things always means actively acquired information. And so it is a question of taking shape, often with great difficulty, rather than losing shape. Thus, we come to experience deformation as dynamism. For example, the idea of penetrability acquired in the potter’s arduous manual experience proves to be fundamental.

Henceforth an impenetrable solid is seen as an outright exception. The outline of its shape corresponds to nothing more than our idleness, a prospect of laziness, and a philosophy of the immediate. If we wish to relate Homo sapiens to Homo faber, we must consider the latter in all manner of actions. Homo faber arranges and kneads; such an individual welds and grinds. For that person certain bodies are juxtaposed, others are mixed together, and still others are dispersed in dust and smoke. Solids demonstrate the great lesson of form and assembly. From liquids comes the equally fruitful and clear lesson of change and mixture. From the phenomena of dust, powder, and smoke, Homo faber learns to meditate upon the delicate structure and the mysterious power of the infinitely small; along this path lies the knowledge of the impalpable and the invisible.

And so the primacy of explanation via solids is compromised at the very core of popular knowledge, in the domain of initial intuitions. Besides, even if we were to assume that the problem of the intuitive origin of knowledge remained unre-
solved, we would at least have to admit that the characteristic of absolute solidity attributed to bodies is a characteristic to be rectified, since the best-known phenomena soon display a departure from the quality of perfect solidity. In reality, our thinking is more in line with the deformation of a body than with the geometric relation between many bodies. Thus, Bergson’s thesis designates only a point of departure. It is unable to account for the complete evolution of objective thought.

In short, whether through utopian assumptions, or through glimpses that describe matter in the actuality of its multiple states, I believe I have restored to my intuition an unfocused and free character brought about by several sensory sources. It will now be easier to sever the link that is always too narrowly established between principles of atomism and geometric intuitions derived from observing solids. Following this polemical preparation, let me now move to a truly positive examination of my thesis. Let me attempt to demonstrate that the intuition of phenomena of dust truly undergirds naïve atomism.

IV

We should, first of all, recognize as fact what in fact exists. Now the experience we have of powder and dust is far from negligible. This experience is so singular and striking that we can speak of a powdery state exactly in the same way that we speak of solid, liquid, gaseous, and pasty states. In reality, in modern science this powdery state always poses problems of its own. For example, we see a more energetic chemical action in powders. This chemical potency of powder derives from a kind of surfacing. Zones of transition and contact will give way to special phenomena. Catalytic actions appear that would have no impact coming from a material taken as a mass. Thus, Auguste Lumière points out that exchanges and reactions that take place in the tissues of a human adult extend to a surface of two million square meters: “However minute the affinities may be of substances coming into contact on the periphery of granules, we can conceive that the sum of all these infinitesimal elementary reactions can become considerable when occurring over such large surfaces.” We might thus say that, through granulation, surface takes on an authentic substantial reality. It ceases to be geometric to become truly chemical.

Even from a coarser and more mechanical perspective, powders work in a special way; their drift and flow lead us to study carefully the shape of their containers or the partitions along which they must slide. But it might be objected that this too
is a new and delicate technique. So let us locate the freshest intuition possible.

Let us first consider a child’s amused attention before an hourglass. Let us contemplate, along with that child, a complex of exceptions! Powder is solid, yet it flows; it falls noiselessly. Overall, surfaces are at once mobile and stable. Mounds will grow; craters will form in which one can see uncaused movement begin. If now we try to reconstruct the overall phenomenon starting from the movement of separate particles, we are amazed to see the regularity and the measure produced by a truly insignificant and lawless body. A paradoxical water clock where solidity displays its fluidity, the hourglass surely provides the first measurement of brief time. It is the glib symbol of a useless duration.

Powder, talcum, flour, ashes—all similarly hold the attention of alchemists and chemists in every period of the development of prescientific thought. It seems that a crushed body, in losing some of its individuality, simultaneously acquires an unexplained character of mystery. Powder arouses the suspicion of poison, it is an essence that, depending on the dose, may bring remedy or death. It is a sorcerer’s material.

At times, it is due to the uniformity of dust that we think we can attribute a broad role to matter. Thus, a late-eighteenth-century author will associate dust with germinating soil. Air, says Deluc, works on terrestrial matter “ceaselessly and in a thousand ways. By simply rubbing all bodies of matter it removes such tiny particles that they are unrecognizable. The dust in our dwellings may well be an example. Whatever the nature of its source material, it is a grayish powder that seems to be everywhere the same. The formation of germinating soil is probably related to that. All surfaces of the earth, from the hardest rocks, the most arid sands and gravels, even metals, suffer the gnawing action of air; and their particles, reduced, decomposed, and reconstituted in myriad ways, are likely the main source of germination.” And so this uniformity, advanced on the basis of our inability to discern specific characteristics, is enough to explain that dust properly encompasses the most varied vegetative needs. In other words, vegetative comparison is no better able to discern differences between grains of dust than is human sensory activity. It would seem that, as solids diminish in scale, they are substantially simplified and thus become elements suited to the most diverse constructions. These particles, adds Deluc, “extracted or fixed by procedures that bring them closer to their initial elements and, in our eyes, cause them to take on the same appearance . . . are thus suited to spread in the seeds of plants, to expand
their tissues, to take on all the properties that characterize each species, and to maintain them as long as the plant exists. After the plants are destroyed, these same particles take on the general character of germinating soil, that is to say a ready-made reserve for germination.  

Let us also note, in passing, the paradoxical idea that dust, the final result of all destruction, is easily posited as indestructible. The attribution of eternity to the atom in certain philosophical systems may have no other origin.

Thus, at the basis of our intuition of powder and dust are very curious judgments of value, since substances in this form are sometimes considered trash and, in others, worthy matter. We are amazed, in fact, when going from one judgment to the other. For example, who has not been struck to learn about new forensic tests? It takes all the talent of a Locard to convince us that a criminal investigation can be explained through microscopic analysis. We had been led, through a pragmatism that was as crude as it was negative, to tacitly assume that substances lose their individuality when reduced to dust. We are therefore quite surprised to learn about the material individuality of the infinitely small. Moreover, thanks to the effortless dialectic of amazement, we are soon led to be amazed at our surprise. Thus, we don’t hesitate to exaggerate newly recovered individuality and to postulate a set of qualities for material particles that are more characteristic than aspects of matter in its massive form. And so it is, as I will show, that naïve atomism assigns to elements qualities that are apparently not related to regular solids.

In addition, we might understand the influence of pejorative judgments often associated with dust by recalling certain related conditions such as wood-rot and rust that keep intuition in the prescientific stages. For example, rot, in and of itself, serves as an explanation, and the seventeenth century does not hesitate to believe in the action of a special worm that attacks metallic substances—dust from rust is considered the same as dust from wood rot. A table of presence might bring the two phenomena together and provide a Baconian explanation adequate for knowledge limited to relating two intuitions.

Along these lines, going on now to generalizations, we will understand that one of the great arguments of atomism, endlessly repeated by the various schools, has to do with wearing down the hardest of bodies. The temple’s bronze doors hollow out under the faint touch of the hands of the faithful. The atom is now a worn solid. After a long success of creative effort, everything returns to the chaos of disassociated and mixed atoms. This theme of the general wear and tear of things,
of the destruction of integrated forms, and of the amorphous mixture of diverse substances is the basis for numerous materialist philosophies that can thus adapt their pessimism to a sort of aesthetic decline of the Cosmos.

The question can also be approached from another angle. If dust and powder are valued for their direct explanation, we will be led to value the pulverization of solid bodies as a truly fundamental process. We will not hesitate, at that point, to explain complicated physical phenomena in terms of the idea of pulverization, which will play the role of a simple idea. That is how Hélène Metzger quite rightly characterizes the psychology of a seventeenth-century chemist: “Like all dabblers in pharmacy (Arnaud, 1656) crushed solid bodies in a mortar. He believed that all chemical operations have some relationship to that one, that they may be finer or cruder, but that, ultimately, the chemist’s entire art boils down to the mechanics of pulverization.” Pulverization is the clear and primitive idea, to which all chemical reactions must be brought back: “What is calcination? Seventeenth-century chemists reply that it is a process which consists in pulverizing different bodies by fire, either by action of the flame’s actual fire, or by action of the potential fire found in acids and other corrosive materials.” In the Encyclopedia (under “pulverization”) one can also read that “calcination, either by fire or, by the assistance of niter and of sublimation into odors, is still, as to its effects, a type of pulverization.” We can thus readily see that, for several centuries, the pulverization of substances was not merely a procedural means, but indeed had the importance, in the mind of the chemists, of a fundamental intellectual framework.

We have observed powder and dust in their rather diminished or at least static and inert aspect. But it is when we come to fine, light dust stirring and shimmering in a ray of sunlight that we really grasp the master intuition of naïve atomism. This is a spectacle we often contemplate in our reveries. It is capable of liberating our thoughts from the everyday laws that regulate active and utilitarian experience. In a way, it contradicts such willful experience, leading us to sever the link established by Bergsonian philosophy between our actions and concepts. Reflections born of this spectacle immediately have a speculative tone. They readily take on the function of learned reflection since they explain the general by the singular and the special, a method used more often than one might think at first glance.
The entire set of departures from usual laws, when manifested in the aerial play of dust, is precisely what makes its intuition so appropriate. The speck of dust, in particular, departs from the general law of gravity. For a truly primal intuition, need it be noted, it floats in a void; it follows its fancy. Of course, it responds to puffs, but with what freedom! It illustrates the clinamen.

Through a profusion of colors and iridescence, the speck of dust dancing in the light also illustrates the multiple properties of an isolated object. Upon looking at it carefully we think we understand that the element, simple in its substance, can be composite in its attributes and modes.

But the principal explanatory value derived from the speck of dust, its true metaphysical meaning, is surely that it brings about a synthesis of opposites. It is intangible and yet visible. A strange object that affects but one sense, that presents itself as a kind of natural abstraction, an objective abstraction!

But let us go further—in this experience what becomes visible is the invisible. In fact, as long as a reflected and diffuse light fills the room with a uniform clarity, the room is empty, the dust is invisible. Let a sharp, straight ray appear and immediately this ray of light reveals an unknown world. This is really the first experience of atomism; this is where atomistic metaphysics touches upon the basic physics of the atom; this is where speculative thought finds support in an immediate intuition. From now on, in fact, we can recognize our right to postulate matter beyond sensation since, in a way, experience has shown us the invisible. So we postulate the atom of matter beyond the experience of the senses. We are ready to speak of the atom of smell, of sound, and of light since we have just seen, in an auspicious and exceptional experience, the intangible atom of touch.

Such nimble and free matter might obey the impulses of the soul; it might be spirit itself. As Léon Robin recalls: “Aristotle, who does not name the Pythagoreans when he speaks of soul-harmony, expressly attributes only two opinions to them: according to the one, whose relationship with atomism he does not fail to point out, the soul is made up of dust particles floating in the air, highlighted by a ray of sun, and perpetually on the move, even in the calmest moments, while according to the other, the soul is seen as the root of their movement.”¹⁴ In both cases, therefore, there is a correspondence between the elements of the soul and the elements of matter. The atoms of the soul, adds Émile Bréhier in interpreting the same intuition,¹⁵ are in equal number to those of the body and are juxtaposed.
to them by alternating one-on-one with them; they are constantly renewed by respiration. How can we not then consider that for early thought, the spirit of life takes shape in a puff of breath; how can we not relate the intuition of the mind to the observation of light animated by atoms that fill an infinite void?

From an animistic perspective a sort of passage to the limit can be discerned that allows us to transcend matter. But in a more general and more material way, that is precisely where the epistemological usefulness of the observation of dust resides—it prepares and legitimizes a passage to the limit. That is the way Descartes makes use of this intuition in his book on meteors. In speaking of vapors and exhalations, he points out that specks of dust are much larger and heavier than the small portions that constitute vapors; nevertheless, he adds, “that does not keep them from pursuing their course toward the sky.” Here one can really perceive the powerful example of phenomena viewed in a ray of light. What dust can do, how could the atom or the fine matter of exhalation not be able to do? If dust manages to escape gravity, how could the atom not find its independence? If the experience of dust is still crude, all that is needed is to pass to the limit and we will attain, through thought, an atomic physics that will give the impression of being rational while still maintaining an experiential basis. Here then, in short, is the progression of arguments that carries forth the initial intuition and that establishes philosophical atomism as a doctrine at once rational and empirical.

VI

In connection with the intuition of dust, one should also study the intuition of the void, for it is not difficult to show that it also is a quite positive one. In fact, upon reading the Greek philosophers, we become convinced that the entire polemic over the void amounts to either aiding or combating that intuition. But in any case, when we first encounter this basic intuition, the void poses problems from a metaphysical perspective by the very fact that it raises no problem from a psychological point of view. Such a polemical outlook is well suited to demonstrate that the void and dust are truly immediate and important facts of experience.

This essentially derivative aspect of the metaphysical problem of the void is so clear that the problem is sometimes stated in a totally metaphorical, even unwritten way. We read in Aristotle, for example, that “if we are to believe the Pythagoreans, the void is originally found in numbers, for the void is what gives them their particular and abstract nature.”
All these arguments against the void are also interesting to my way of thinking in that they underscore the power of a first intuition carried into the most varied domains. Thus, for Plato and Aristotle, it is a question of combating the idea of a void that would be an instrument of general annihilation and that would bring to all substance the contagion of nothingness. They argue, in fact, that in the void, bodies would lose their specific properties. For example, with respect to motion, the void would erase individual dynamic properties. Thus, Aristotle concludes that “all bodies in the void would have the same velocity, and that is not admissible” since the void would, in fact, take away from motion the fundamental Aristotelian characteristic of velocity. Besides, in a more general way, the properties of bodies in Aristotelian physics are, as we know, entirely relative to their environment. A given property is more than localized, it is truly local. The attributes of a substance must be forced, in a way, to remain in the natural venue of that substance. Otherwise, the substance could not really retain its attributes, which would undergo a sort of metaphysical evaporation. In the final analysis, Aristotelian dialectic is led to replace the intuitive void by a space that, if not real, is at least necessary to assure that objects retain their real qualities. It is acceptable for the space to be empty of substance, but it must maintain a relationship to the substances it contains. It must realize the minimum necessary for the principle of sufficient reason to be applied. This point of view is very clearly summarized by Léon Robin: “With the venue deprived of all natural properties of location, what reason would there be, in fact, for a body to move in any particular direction? How to explain, as well, the accelerated motion that, to the contrary, a body displays when in the vicinity of its natural venue?” But really, in implementing rational necessities, all we did was fill space with reasoning, and we still have to make the characteristics produced by the immediate intuition of the void reappear. Thus, Barthélemy-Saint-Hilaire underscores the dialectical character of properties attributed to space and bodies by Aristotle. Matter that fills space, he says, “is not such that it can oppose the least obstacle to motion, and motion occurs with such a constant and perfect regularity that, evidently, nothing troubles or hampers it.” But then, who does not see that positing metaphysical fullness amounts to attributing to it all the characteristics of the intuitive void? Fullness even has as its only function to maintain the properties of things, to bind attributes onto atoms in some way. The initial intuition has been enriched rather than impoverished; it remains whole. Once again, metaphysics has recovered what it had willingly lost. After a long detour, we must come to the conclusion that space is not a physical environment like any other, that it neither impedes nor produces motion, that it leaves undetermined all the reasons it contains for forecasting phenomena. Meta-
physical plenty remains a physical void.

If the reader hesitates to follow me in this affirmation of the persistent character of the first intuition of the void, I have in reserve an argument that will otherwise answer an objection that is quite natural.

Surely, no one has failed to object that, in fact, the experience of the void for the ancients as well as for common knowledge is obviously erroneous since all the early physical experiments are carried out in air, with an almost total ignorance of phenomena peculiar to the gaseous state. We should then concede that the direct intuition of the void corresponds in reality to the experience of a physical state that, in itself, is well determined although poorly known. But an error of thought or expression has nothing to do with the truth of an intuition. What must be called the tangible perception of the void is closely linked to a quite positive observation.

Let us try to specify the experimental characteristics of this intuition. Air for the ancients was always the wind. In ordinary experience, if air is immobile, it somehow loses its existence. Wind is always a power of coordination. That is why the disorderly movements of dust in a ray of sun are not attributed to the wind. Here again, these movements represent an exceptional state, and, through a sort of dialectic, they display an ambient void as still another exceptional state. Immobile air is decidedly the intuitive void. It has no action, and it is the indicator of nothing, the evident cause of nothing. Accordingly, by taking the experience of aerial environment such as it appears initially in its general and simple aspect, it has to be recognized that this experience is well suited to providing a proper substitute for the void. In the final analysis it cannot be argued that the scientific error of an intuition destroys the power and clarity of that intuition.

This immediate and enduring clarity explains the difficulty brought on by the first scientific experiments following the invention of the air pump. By following these experiments over the course of the seventeenth and eighteenth centuries, we perceive the transition of an absolute and clear idea to a relative and confusing one. This transition was psychologically difficult and the idea of a relative void, so familiar to us now, was long a difficult idea to analyze.

Initially this relative void was taken to be essentially artificial. For a very long time, it was called Boyle’s void, after the English physicist who multiplied the
experiments. It was a technical state whose properties seemed as new as radium must have seemed at the beginning of the twentieth century. Considered to be a paradoxical state, it drew astonishing, extraordinary, and legendary observations. To give just one characteristic example, let us cite the claim of distinguishing between properties of the void when air is removed from a cubic vial or from a spherical one. With the action of the air pump, the first would shatter, the second would resist.\textsuperscript{22}

Finally, more learned intuitions, based on the image of rarefaction developed through statistical analysis, very slowly began to help follow experiments in their particulars. These intuitions have profoundly permeated the culture of our time. We must forget them in order to appreciate the play of detail from the earliest intuitions.

To sum up, atomism is, first of all, a visually inspired doctrine. To ambient air corresponds a void of optic sensation. The material characteristics of gasses can only be understood through a scientific experiment, with technical means that are difficult to apply. Optical characteristics thus conserve a sort of natural explanatory value. Dust and void apprehended in the same glance truly illustrate the first lesson of atomism.
NOTES


2. [Lasswitz, Atomistik und Kriticismus.]

3. [Ernst Mach, 1838–1916, Austrian physicist and philosopher after whom is named the number that identifies the ratio of a given speed to sound.]


6. [A mesomorphic state (“état mésomorphe”) is defined as a state of matter whose symmetry is intermediate between a solid and a liquid and that is found especially in certain elongated organic molecules (liquid crystal) “état de la matière dont la symétrie est intermédiaire entre celle d’un solide et celle d’un liquide et qui se rencontre surtout avec certaines molécules organiques allongées (cristal liquide).” http://www.larousse.fr/dictionnaires/francais.]


9. Ibid., 30;

10. [Dr. Edmond Locard, Bachelard’s contemporary, established the basic principle of forensic science that “every contact leaves a trace,” known as Locard’s exchange principle. https://sites.google.com/site/apchemprojectforensicchemistry/experts-in-the-field.]

11. H[élène] Metzger, Les doctrine schimiques en France du début du XVIIe à la fin du XVIIIe siècle (Paris: Presses Universitaires de France, 1923), 61. [The “dabbler in pharmacy” mentioned by Metzger is E. R. Arnaud, a Doctor of Medicine who published an Introduction à la chymie ou à la vraie physique in 1656, where he sought to improve medicine by “having the physician enter the pharmacist’s laboratory to discover . . . that the sciences, far from combatting each other, must strive for mutual enlightenment” (“faire pénétrer le médecin dans le laboratoire du pharmacien, lui montrer . . . que les sciences, loin de se combattre, doivent essayer de s’éclairer mutuellement”) (Metzger, 59–60). Hereafter cited as Les doctrines chimiques en France.]

12. Ibid., 372.

13. [The reference here is to the famed work of the French Enlightenment, the eighteenth century Encyclopédie, edited by Denis Diderot and Jean le Rond d’Alembert.]

14. L[éon] Robin, La pensée grecque et les origines de l’esprit scientifique (Paris: Albin Michel, 1923), 82. See also 145. [Hereafter cited as La pensée grecque.]


the metaphysics of dust · 31
16. [With this “sort of passage to the limit” Bachelard seems to be anticipating the calculation to the limit that will be used in calculus to measure the infinitesimal.]


19. Ibid., bk. 4, chap. 9, §18. [English trans., bk. 4, chap. 8 (216a, 20).]

20. Robin, *Lapensée grecque*, 337. [The 2015 printing of *Les intuitions atomistiques*, on which this translation is based, mistakenly attributes this citation to Aristotle. The quotation, as indicated in the original 1933 edition, and as noted here, is from Robin.]


22. This observation continues to be related in Diderot and d’Alembert’s *Encyclopédie*, s.v. “Vuide,” last column.
Here comes a great new book on stupidity: La formation de l’esprit scientifique. We recognize the genius by this sign: that he is not satisfied to just designate that which cannot think, but that he arouses it and makes it alive. In the sciences, everything changes: it is the intelligent books that are difficult to write; we are not intelligent in the sciences at little cost, at the cost of literature or philosophy, at the cost of words. Because words take revenge.

An essay on dormant physics written by an alert physicist, this book is paradoxical from the point of view of physics: an instrument of precision cut with an axe. Able to move scientific concepts by an ångström, it moves philosophical notions in a centimetric area. It assumes a repertoire of science that is exact, precise, carved out. It sends it back without, or almost without, touching it, speaking while departing from it, without it. At the same time, it speaks the language of pre-science: alchemy, astrology, amusing electricity... before which recedes the first, that of positivity. Leakage and backflow, which permit one to judge, by recurrence, that these two lexicons, the present and the absent, turn their back on one another, without correspondence. And since one speaks of the things themselves and of closed systems, the other does not speak about it: it speaks therefore of man him-
self and of his relation to the world. Pre-science speaks of being in the world, of self-awareness or awareness of others. Physics, the science of the world, upon reaching maturity (its formation completed), leaves an archaic matrix. Physics kills this matrix. And this is something like a human science, an archaic discourse of man. A philosophy. In passing: how many obstacles or repudiated notions here belong to philosophy? How many times does it pass for pre-science? Or pre-science for philosophy? Let’s try to speak of this old discourse. Thus emerges another language, another human science, archaic or new. To specify, it is not the new scientific mind speaking of the archaic; it is the new (?) human science (?) that speaks of the old. Positivity stays between parentheses for this subjective synthesis.

Hence come a few floating words. Three examples. At the zero degree, if I dare to say, Bachelard uses ‘phenomenology,’ which is in its proper place, given the above, even ‘phénoménotchingue.’ These words signify nothing other than the discourse on the phenomenon, or again, the discourse held on or by the laboratory tools. Note that this is the literal or etymological sense. In the bent degree, ‘psychoanalysis,’ which hardly refers to Freud, and even then only from the outside, is used more like an “analysis of the psyche” in question: once again, the literal or etymological sense. This soul is religious, ethical, intellectual: the classical soul of the moralist, perhaps that of the confessor, probably that of the psychagogical professor-guide. We’ll have to come back to the crucial degree of this bending. And finally, in a normal degree, ‘formation.’

Formation is a good word for the epistemologist. Spirit (esprit) is a rather bad one, to be honest. Religious, when it is saintly or diabolical, a bit alchemical if it is drawn from wine or salt, medical of classic times when, in the plural, it attaches to animals, the positive or scientific spirit smells its alembic, or heresy. Without irony, the tradition brings it from far off: since the birth of the history of science and until recently, this discipline has been constantly perceived as the adventure of the human mind. The word is to be found everywhere, in Montucla, Fontenelle, Condorcet…Bachelard. Formations, on the other hand, at once cuts through the whole classification of science and is everywhere pregnant with positivity. Hence the importance that Comte gives to the term. It stems from grammar, syntax and morphology: case formation, verbs, prepositions…It stems from logic, where the rules are laid down to filter well-formed expressions. From biology, where Comte drew from: puberty, passage toward and establishing of the physiological state of the adult. From embryology in particular. From geology: ground layer of such an
origin, of such a nature. The psychology of form. The constellation of socio-political or socio-cultural functions: tactics, military or militant, combat group, divisions, unions, classes, parties...in the sense of superstructures, liberal arts, institutions and laws. Finally, the educational meaning of the institution of children. The term is omnidisciplinary. All things considered, it refers to a construction, an architecture and a genesis. Either a spatial drawing, a plan, in the sense that we want, and a lapse of time. Hence the diligence of epistemologists and historians of science, whose major problem is to confront a system and a history, structures and a future, who have in mind a block universe of space-time. Who should therefore be relativists, but who support above all the biological nuance, since the introduction of the term formation by Comte. Its normative connotation, which gives the standard reading in a recurring fashion, contributes again to its election. That said, the great works are settled on it, and explore the formation of set theory, the concept of reflex, the scientific mind, etc... Thus, the importance of this transversal definition resides in the fact that it can index the references of the philosopher speaking of science. Let the word be fixed on the scale, taken in a unidisciplinary sense, and all the discourse will be lateralized. The Husserlian tradition of the Krisis privileges the geological layer, Piaget the institution of children, others social training. And Bachelard?

He uses the term to the normal degree. This means, for a change, in the complete semantic range. Normal, that is to say without lateralization. Thus, the book is obscurely guided by the said encyclopedic or interdisciplinary circulation. It begins, or almost does, with general knowledge and verbal obstacles: the pre-scientific language is poorly formed. We shall respond to the question of how it is formed. And it finishes precisely with a long chapter on the institution of children, on the failures of training at school: teaching produces the poorly formed. Between these two limits, we mark fairly well the biological heritage of Comte: beyond the three laws of the three states, history, spirit, and soul of which one is, precisely, puerile, we get the idea that maturity is positive, that the positive age is the mature one; we cannot go back upstream of the established norm, where the unformed is unreadable by the formed norm (hence the change of language in order to be able to speak); one no longer needs one’s parents: mature knowledge rejects theology and metaphysics, the gods and notions, Mercury and phlogiston, but above all man who is the occupation solely of pre-science. And since there exists, for Bachelard, a point of non-return, no one could see how to avoid something like an epigenesis in the history of science. How can esprit come to the young sciences?
We noted that there is a lacuna in the encyclopedic range with the term *formation*: it makes little sense in physics. A good word for the epistemologist, a rather bad one for a physicalist. Second reason for changing the language, when it comes to interpreting the prephysics, to speak grammar, logic, biology, the analysis of the psyche. *Preformed* physics has no physical meaning, it is *unformed*. It speaks about language, reason, life, the soul, society, the world and nature, but never of the only object of physics, namely a closed system. Yet, of closed systems in general, taken directly as object, will be born the theory of information for which all formation remains a thermal scandal, an epistemological paradox. Formation makes no sense in physics because physics shows us that it is physical non-sense. It is thus impossible to speak in a physical sense about formation in the physical sciences. Bachelard will therefore talk about pre-science in all the other languages. These other languages develop from this lacuna: it is the first secret of the book, that for which the language of his own science recedes. In this, and perhaps unknown by him, Bachelard is consistent. A closed system is not something that is formed, it is something that is reduced. History, when it introduces a closed system, shows less of a break (*une coupure*) than a carving (*une découpe*). The invading formations of language and thought must stop.

Bachelard himself fills in this lacuna elsewhere in overabundance. But his successors, in that they do not speak from this known and assumed blind-spot, will take his language for granted and will leave the place for physics gaping. As of yet there are left, at least in France, only philosophers of the logico-mathematical sciences on one side, and of the biological and socio-political sciences on the other. It is enough, once again, to take a word very frequently employed by the epistemologists in its widest interdisciplinary range: the word *class*, which is logico-grammatical, mathematical, biological, socio-political, and pedagogical, to watch unfold, newly gaping, the same void. The concrete object removed, idealism remains, well hidden, moreover, by a long discourse on the real. Our philosophical times are marked by the disappearance of the object.

We have varied on the term formation. Its semantic range is far from being exhausted when we followed a scale of the sciences. On the side of the institution of children, there remains, in the region of norms, the moral meaning. Reform. Is the famous epistemological break the outcome of another protest, or the same, if we think that Galileo was condemned by a counter-reform? The importance given
to the polemical turn commits us to this path. It is by the bending of the word psychoanalysis that the entire ethical heritage will impose itself. Quite frankly, there is not a word of psychoanalysis in La Formation. Just listen to the language it mobilizes: it connotes a morality. The content analysis is overwhelming; it is a Treatise of the Reform. Of the mind, heart, soul, body, academic world. Formation of the scientific mind, I am afraid that this means, in truth, reform of the soul desperate to reach the quintessential. Read carefully the advice of alchemic practice to the alchemists (Formation, transl. p. 57-58) and see whether the epistemologist’s advice to physicists and chemists is not, perchance, the same?

Proof, on the spur of the moment. Bachelard announces, from the first chapter, that he is working toward the moralization of science (p. 32), through a catharsis of the impure (p. 29 and everywhere). The rectification, the well-known road to success, is at first only a correction, thought of in a provisional morality (p. 25). Hence the revelation of the diagnosis itself: the mind forms itself through reforming itself (p. 33), the first theorem of a book, where the last could very well be: objective control is a reform (p. 238). The ethics towards which the professor leans is of a high austerity: it reproves the world and the socialites, as understood by the monasteries and Port-Royal; the salons and the marquises, who faint before the thunder, have hot flashes in front of the electric machine, and who put their virtue at risk. It shuns frivolousness, it declares that amusing electricity exhibits cannot be but false, and it asks its disciples to enter into the cloister of the school or the laboratory (p. 41, 43). Be boring, like Coulomb (p. 38), and you’ll be taken seriously among your peers who control you. Come, be sad and you will be philosophers (p. 146). Prepare for intellectual asceticism (p. 241), even heroism (p. 141). Beware of dangers, a sagitta volante in die, a negotio perambulante in tenebris, ab incurs et daemonio meridiano. Here they are, all at once: the instincts are the obstacles (p. 25), intellectual joy is sometimes dangerous (p. 64), like intimate satisfaction (p. 238, 242). No ecstatic states of the soul (p. 238). Hence the rule: the mind does not want to enjoy quietly (p. 245). I spoke of the demon, one must exorcise it (p. 49). I spoke of the night, here are the shadows of knowledge (p. 24). I will speak later of trade and of the arrow of Eros. Having begun with exorcism, the text ends with a manual for fraternal confession. The last chapter is impressive. Do not remain, without surveillance, in solitude (p. 239); let us admit to our intellectual faults, let us confess (p. 240), break up with pride and greed, murmur: “error, you are not an evil,” since our intellectual mistakes are forgivable (p. 241), erring compromises (p. 238); we tolerated impurities (p. 247), we renounce (p. 246), we ask that our impurities be amended by a reprimand (p. 238); let us return to the beginning;
after incrimination (p. 24), here finally there is repentance (p. 24). The confessor
will say: the more recent the fault, the more serious the sin (p. 160). The book is
framed by the act of penance, structured, one could say, like the sacrament. For
confirmation: the last page speaks about changing the heart of man (p. 247) and
the first takes the Pauline accents of the texts on the shedding of the old man: in
front of the mystery of the real, the soul has difficulties making itself ingenuous,
the mind is very old, science makes it younger (p. 25). Needless to say, these au-
thentic citations are drawn from a background of exceptional abundance.

To rejuvenate (rajeunir), as far as I know, is the opposite of formation, in the
physiological sense. Hence reform, in the moral sense, as a return or recurrence
to a pure form. But let’s extend the biological metaphor for a moment, to see that
it is indeed a metamorphosis, as when the old man casts off his skin. Training
then is transformation. To rejuvenate, the text goes on, is to accept a sudden mu-
tation that must contradict a past (p. 25). The well-made head must be remade. It
changes species... By spiritual revolutions...man becomes a mutant species, a species
that needs to mutate, that suffers from not changing (p. 26). Hence Bachelard’s
fascination with the Kafkaesque theme of coagulation, announced by a theory of
the deformation of concepts (p. 69); hence the inverted themes of the variables
being joined together, the mathematical coordination (p. 73), the cohesion and
cement (p. 76), the semantic circle where language clots, hardens, seizes (p. 75-
77). There is metamorphosis, transubstantiation in the right direction toward a
good form, that is, mutation toward coordination; and there is transubstantia-
tion in the wrong direction, toward a bad form, if the speech coagulates. On the
one hand, psychagogy, reform: the object instructs me, modifies me (p. 246), it
properly arouses new organic functions (p. 247). Right in the middle of the page,
Bachelard skims along the sacramental word, and approximates it with consub-
stantiation. On the other hand, the announced picture, the expected beast, which
slowly hardens near the stove, in its crab shell, the dunce, the unscientific species,
the subjectivist species, whose immobility instructs eminently (p. 242). We did
not miss the bestiary, of which our pre-science is abundant.

Reform (moral), mutation, metamorphosis or change in species (biological), the
term break (coupure) is the mathema of discontinuity or of distinction. It happens,
in fact, that we may spot, here and there, certain “dates” when the scientific lan-
guage undergoes a sudden translation, of the sort after which no one speaks as be-
Entire texts, by groups or sets, are thus composed in a dead language, whose deciphering is, downstream, a prehistoric, paleontological undertaking: the logic of Lullian art, for example, after arithmetical combinatorics, alchemy itself after Lavoisier. Then again, the gap can only be identified from a distance. Looked at closely, it is never so simple: Copernicus and Galileo *aristotelize* with ardour, as do thousands after them, within the realm of science proper, like Leibniz; and Jacques Cassini (the son), in the middle of the 18th century, long after Newton's victory, continues to produce vortex models. And I say nothing of the crucial example of revivals: look at the question of matter, atoms, and fire. Sure, the theory of the break is compatible with a normalized, that is to say idealized, history, which explains its mathematical reference. But I would rather that the theory were compatible with all histories. For the moment, let's leave history as well as science. What is at stake? Here we are dealing with the basic language that the scholar, the historian, the erudite can lean on, and by which they are most often possessed. Bachelard, we are showing, relies, perhaps unwittingly, on an ethics, roughly the ethics of the founders of the university, in which we find a blind jumble of positivist themes, Christian themes, and even more archaic themes based on doctrines of initiation, asceticism and austerity. What is at stake is the change in this basic discourse, not what it is talking about, but the very discourse. It is a question of substituting the moral (and, thus, political) vocabulary of the continual progress of the mind with the political lexicon of the combat won at once, at a predicted or just at a given moment, against an adversary to be destroyed; of substituting for the vocabulary of reform, that of revolution. This is the real issue of the discussion of the continuous and the discontinuous. The battle takes place behind history and behind science: what is at stake is to decide who will finally be the master of knowledge or the owner of history. The adversary is no longer the demon of confusion, the gnoseological demon of affects or prejudices, it is the demon of empire and of appropriation. In the face of this fundamental struggle, at the forefront of the scene, science and history have nothing but the status of elective objects that are there to be seized, and which are worthy of being seized. They were, in fact, in someone’s hands; the battle plays out for the change, or not, of hands. And so, neither history nor science can settle the debate. It is undecidable from within science or from within the history of science; it is never, as far as I can see, the stakes that decide the winner of a competition. Assuming that it is possible to analyze these ‘objects’ directly, which is far from clear, one can bet a thousand to one that the result will remain silent about the alternative of continuity versus discontinuity. Working from dawn till dusk, one can rejoice in contrary and equivalent arguments. And finally, considering the fundamental clash, are we
really facing an alternative in its proper domain here? One is never careful enough when employing a sectorial or dichotomous lexicon: it is often less revolutionary than it might seem. There have been many breaks, between Greeks and barbarians, heretics and Orthodox, whites and blacks, elites and common folk... that, before doing it again, before operating the cleaver, one had better be wary that those speaking dead languages (or languages declared dead) are once again excluded by some elite. Look at how, even in Bachelard himself, vocabularies of moral reform and of scientific revolution coexist, of biological transformation and of genetic mutation; look at how, backed by a traditional ethical discourse, he will consider curious ‘breaks’: the casting off of the old man,12 passage from species to species, solutions and absolutions, mutations, scholarly utopias. There are, yes indeed, languages that remain foreign to one another; there are also dictionaries.

But back to basic language. There was a time when the confessor and the penitent had manuals to read into the soul. Among them, we find some very ingenious ones, in the 17th century for example, compared to which our classical treaties of the passions are lacking in finesse and penetration. The less good ones offered tables with a view to this decipherment. The simplest and best known is the rubric of the deadly sins. If it is then true that the moral lexicon of fault and sin dominates, La formation, as a treatise on the reform of the soul, as a manual of scientific ethics well-suited for fraternal correction, must contain a similar list. Non-science is the place of the cardinal sins, it can be mapped through pride, avarice, lust, gluttony, and sloth. The evidence is once again overwhelming; so strong that the demonstration risks repeating the text, unnecessarily. The reader will complete it for himself.

Three special chapters are devoted to three of the five major vices. The psychoanalysis of the realist (VII) reprimands the miser, the myth of digestion (VIII) surprises the glutton in his sweet apathy, the libido (X) rummages the lustful. You will say: this corresponds to the three stages of psychoanalysis in a somewhat deranged order, anal, oral, genital, and these texts are induced by the teachings of Freud, not by conventional morality. The argument would be convincing if the sanction of pride and of sloth and the praise of wrath and of envy were not found dispersed all over a book dedicated to work and humility, without anything more than a circumstantial relation to the new psychology. Let us make this clear. Between the language of alchemists and salon physicians who claim to signify the
object, but who speak only of the affective subject, and the language of science reaching maturity, which signifies the object but owes this performance to a psychagogy, to a catharsis of understanding, to a gnoseology of the subject in the first person plural, between these two languages which are foreign to each other, Bachelard suggests a dictionary; this dictionary cannot catalogue the translation of the objects themselves: the question how one says phlogistic in chemistry has no meaning, and electricity has completely forgotten its yellow amber origin, just like nitrogen (l’azote) has forgotten the first and last letters of known alphabets. There remains the possibility of translating the subjective states, of saying how the scientific mind is formed as such. The dictionary then builds itself on the human sciences, and Bachelard chooses psychoanalysis, which shows his insightfulness at the time. Hence the venture: the dictionary, in turn, establishes itself on an archaic terrain with respect to the human sciences that have not yet reached maturity, on a pre-scientific soil in the region of the operating subject. Hence, it models itself on the old discourse of man, the old morality culture is impregnated with from one end to the other. Mutatis mutandis, Bachelard is confronted with the same adventure as the alchemists in the chemistry of the object: his lexicon is seized by the dominant language, his psychoanalysis returns to the state of alchemy, it veers toward moralizing initiation. It no longer translates anything, because the libido remains lust, sadism wrath, and anality avarice. This venture is ordinary: just as the soil has remained the same, the puritan ethics is always well suited to the psychoanalytic project and its practitioner is seen as a confessor. Instead of devoting himself to a psychoanalysis of the pre-sciences, Bachelard ends up treating the former as a one of them. The turn, moreover, is so general that it is significant: maybe in this case we stumbled on a truth. That said, here the dictionary is no longer a tool of passage between two foreign languages, the two basic languages being identical. It turns out that no gap whatsoever exists between Bachelard’s psychoanalysis and pre-scientific morality. And the initiation to the scientific mind is indeed the same catharsis as the initiation of the alchemist: quod erat demonstrandum. The underlying semantic network, as elsewhere, coagulates, hardens, and seizes.

Quick checks: five variations, on the spur of the moment. Here is the realism and the joy of owning, a miserly joy and Harpagon complex (p. 136-137). Its fundamental axiom: nothing is lost, nothing is created, saying of the miser (p. 137). The dust of pearls attracts the miserly member of the middle class more than the prodigal prince (p. 142): by the way, who is the father, who is the son, a question of psychoanalysis or of politics? Precious stones, objects of diligence in archaic
knowledge, are concentrations of fortune, maximum value for minimum space: it is intelligent avarism (p. 142-143). It is necessary to have in order to give, but to give remains more difficult than to receive, postulate of the petty (p. 146). Let us finally break with these greedy states of the soul (p. 238, 241). The reader can glean even more: let a few ears (of corn) drop on purpose, he said.\textsuperscript{13}

Second harvest in the fields of sin. The emerald is chaste (p. 140-141), a figure of purity omnipresent and often virginal. The lover is patient like a scholar (p. 185), hence the libido, insidious, ends up surfacing even in this heart of stone completely occupied with the aridities of the intellect (p. 186). Alchemy indulges, blindly, by proxy, in all fantastic manners, onanism (p. 188), incest (p. 189)...even jealousy, when its partisans beat their wives (p. 190). What turpitude! (\textit{ibid.}). Never did a scientific treatise write such things. Thus, the whole chapter describes the exercise of lust, including the tired attempts of the old man to regenerate himself, this old man of whom we do not know whether he is Booz, David, or Saint Paul himself. Hence the conclusion: objective knowledge must be a \textit{tranquil} knowledge; confused youth or Faustian old age are obstacles: \textit{vade retro}. Alas, educators do not work to provide this tranquility! (p. 209).

Where to pick becomes where to peck, and then to devour. With the reign of science, gluttony has disappeared from the University: to be convinced, go seek a \textit{cookbook} at the library of Dijon (p. 37); from you to me, we must find there even fewer arts of love. Do you want some recipes? They abound in non-science: take and mix some bread, mutton, lemon, spinach, watercress, honey, brandy (p. 74), you get a kind of gruel; soaking in a garlic juice, seasoning (p. 178) (by the way, the article of the \textit{Encyclopedia} was not from the hand of Diderot). Taste and smell (p. 74)\textsuperscript{14}, the electric current, for example, and decide if it is acrid, tangy, sweet, spicy... (p. 110-111). Digest with the ninth chapter: stomach and retort (how I did not know that the still has a cucurbit!), guts and excrement, we return to something like the realism of the greedy. Conclusion: it is necessary that the unconscious be \textit{disturbed} to advise such uses, such follies (\textit{vésanies}) (p. 183). How can the idea come about? See psychoanalysis turn to scandal. In Freud, coprophagia is explained, here it is \textit{incredible} (p. 183). All of our meals are deodorized (p. 239), in the austere scientific banquet, where our peers banish inebriation: the enormous subjective success that is an inebriation would be the most unrectifiable of errors (p. 238). To dream of lost Greekness.
Let us together abandon pride (p. 240), the will of repressed power, anarchic and satanic tendencies, the need to be master of things in order to oppress people (p. 48); I have cited exorcism and conjuration, here is the Luciferian sin. The worst, because the temptation remains: to provoke the philosophers, to win over people by people in talkative reasoning, is a sweet success for the will of power, but to be right, to have reason on one’s side by things putting us in the right, that is the immense success where the luminous will of reason triumphs (p. 244). Perhaps the worst is committed to satisfy the narcissism too frequently induced by a literary culture (p. 26) that loves parades (p. 92-93). General knowledge, universality acquired too quickly, is the sign of a thought in a hurry to admire itself (p. 71). No sooner has it advanced one of these grandiose unification hypotheses than it makes a show of intellectual humility. But this humility, talkative and tardy, is a poor disguise for a primitive immodesty. The basis of a knowledge that is generalized beyond the possible contradiction by objects is pride (p. 95).

Science requires humble people, certainly, but most of all workers. It has no use for inert (p. 66), indolent (p. 245), lazy people (p. 73). The last chapter, where the ethical vocabulary increases to a maximum density, forms a hymn to work, but the whole book is practically this anyway. Hence some celebrations: of constant and sustained effort (p. 242, 245-247), stimulation (p. 238), fatigue (p. 239-241), activity (p. 242), difficulty (p. 243, 249), construction (p. 238) and will (p. 248). Non-science is a collection of lazy sophisms, science a coordination of worked out truths, rectified. Formation and reform: the more difficult a work is, the more educational it is. Come on, back to work, suffer, fight and die without murmuring, you will be a man (p. 249). Get rid of the body (p. 154); life spread everywhere is an obstacle (chapter VIII). Final stage: Kipling, or Vigny, or the Stoa poikilè, in short austerity. To dream of midday dances.

The list is finished. But it is summarized twice in the text itself. Moral initiation, or reform: one must purify one’s soul, despise money and gold, practice austerity, self-denial, be patient, be at work in a relentless (de manière acharnée), disembodied (décharnée) way. Heretical and perverse, Faust calls the devil to satisfy his passions. This is the ethical program of alchemy (p. 57-58). Compare it now either to content analysis or the terminal program (p. 240-242), and the book closes on itself, in perfect coherence. At this point of fusion, where the scientist is the same as his ancestor, most likely lies the secret crucible of the oeuvre that was about to come: for the one who was both the physicist of the complexity worked, rectified, formed, transformed, formalized, and properly became an alchemist of the form-
less material imagination.

La Formation is a prehistory and, as such, something like a psychagogy. But the archeological journey is organized by a purgative ethic of knowledge. Bachelard announces a floating plan(e), whereas the book is fairly well organized, according to the old list of deadly sins. The learned soul, in its third state, is initiated to the longing for abstraction, rejuvenated (p. 25) by shedding the old man, is a pure soul: humble, insensitive to money and precious stones, modest, sober and laborious. It has pronounced the three vows of the university clergy: poverty, chastity, obedience. Alone in front of its object, the learned soul is a beautiful soul. A little boring, to be honest, like Coulomb’s science (p. 38).

You say, Bachelard did not go to the end of the list, which demonstrates a poor reading, a partial key. There remains envy and wrath. Response: the practice of positive science preciously preserved these residual vices as virtues, as its own virtues. The new priests still thunder like Jupiter at the top of the hierarchy; they delight in terror, are obsessed with degrees, and color their competition with the greenish yellow of jealousy. Bachelard’s catharsis is incomplete: beautiful souls and wicked city. The scientific utopia has still not built its Thélème. It does not seem like it even wants to. Why not?

The relation of the subject to the object that was, for centuries, the basis upon which science and theory of knowledge constructed their empire, was formed, not by nature, but by civilization, in a brutal mode. The original sin of destruction is at the origin and foundation of our knowledge. To take, to grasp—Western man is an intellectual predator. To know is to hunt, violate, have power over, destroy. Listen to the great commandments of this dawn of science. We only command nature by obeying it, make yourself its masters and possessors, the object is nothing but an obstacle, progress follows polemics, conflicts, problems are to be solved, dissolved, volatilized... Ongoing speech of the killing, that of analysis, in the literal sense. Wickedness at the root of knowledge, wrath, envy, as desired norms, as cardinal virtues. Listen to Bachelard himself, here and everywhere else. We know against previous knowledge, by destroying, overcoming the obstacle (p. 24-25), thoughts are aggressive, polemical, we think our phenomenon through criticizing the phenomenon of others, we keep toiling away (p. 30), the scientific spirit must be formed against nature (p. 33). This is what we hear, at the very beginning; the
same thing, as an echo, at the end. Following the confession of the sins of the pleasures, school utopia exasperates envy by accentuating the hierarchy. We reward the head of the class by giving him the joy of teaching the second, the second is the monitor of the third, etc... (p. 242); when we know that the teacher is a sadist and the student a masochist, that pedagogy is the relation of the weak to the strong and the field of revenge (p. 245, 246), we know that we have been living for a long time in Utopia, in this one at least. In short, you have to be right against someone (p. 242). Envy, wrath, the capital virtues of the reactive researcher. Knowledge is against: against nature, against its own knowledge, against the self and the past, against others one by one or collectively.

Our rigorous science teaches us this, without saying it, with words that we do not listen to. Everyone is shocked that knowledge is no longer wisdom: it never has been since its first formation, since the criminal act was its act of birth, in the shade of Jupiter’s flamines and of the legionaries of Mars. Knowledge is allied with power, it is power in its very essence, not only since empires have recognized and stolen its might, but since it has established itself as knowledge at the loci of strategy, of conquest and of the empire. And now, under penalty of death, we are forced to outline a more archaic prehistory than that of Bachelard, to purify the sources of science poisoned, from the beginning, by terror. It is no longer a question of the fine list of capital sins, but of our collective survival in the face of capital punishment. The purity of the soul is child’s play in face of this risk.

We dream of a Quirinus who would return, in part, the painting. What would happen if the modest workers of proof, still and evermore reactive, and reactive by the nature of tests and proofs (épreuves et preuves), discovered all of a sudden the truth, incredible and naked: that the intimate motivation of research, that the key to discovery, that the possible disclosure of the true intuition, resided neither in competition, nor in the desire to dominate, but in rejoicing?
NOTES

1. [Editorial note: an allusion to a passage close to the end of Formation (transl. Mary McAllester Jones, p. 239): “Landry said that it is an easy matter to move an object lying on a table by a centimetre; moving it by a millimetre requires the complex interplay of antagonist muscles and is much more tiring (…) However, moving an object (…) by a millimetre is not yet a scientific operation. Scientific operations start at the next decimal point. To move an object by a tenth of a millimetre you need a piece of apparatus…”]

2. Positivism is a physicalism. It judges science and pre-science in the court of the physical method. Hence the elimination of ideology or psychology, condemned or suppressed. Then physics changes, and its method reintroduces the observer. Immediately the positivist gap is filled. To see the theological and metaphysical eras from this restitution, the new physicist mind reads pre-science from the vantage point of psychology. But physicalism is invariant, and its lexicon (formation, mind…) is Comte’s terminology. We have changed all of that: nowadays, we think we are turning our backs on Comte, but we only turn our backs on physics, by privileging the logico-mathematical and socio-political spheres. The object is lost: this rigorously defines the new idealism. [Note by the author in the version of Hermès II. L’interférence, p. 204.]

3. The mind is the subject of science as well as its object. Thus the mind informs its own history, as it is informed by the latter. This finishes with Hegel. Positivism: the mind is the subject of science and the object its object. This finishes with Bachelard, and with his bipolar epistemology, rationalism and realism. Henceforth: the subject-object opposition disappears, to make room for the idea that intersubjectivity is the control of science, upstream control of its production, downstream of its achievements. Control or regulation. [Note by the author in the version of Hermès II. L’interférence, p. 205.]


5. This could be called the spontaneous science of the philosopher. [Note by the author in the version of Hermès II. L’interférence, p. 206.] [Editorial note: This is a reversal of a concept by Louis Althusser, namely what the latter called the spontaneous philosophy of the scientists. See Louis Althusser, Philosophy and the Spontaneous Philosophy of the Scientists & Other Essays. London/New York: Verso, 1990.]

6. [Editorial note: Here Serres refers to a triple tripartition Bachelard makes in the “Discours préliminaire” (Foreword): a partition of stages as periods in the history of thought, one of stages in terms of degrees of abstraction, and a partition between three types of ‘soul’ (âme) corresponding to those stages. Cf. Formation of the scientific Mind, p. 18-21.]

7. [Editorial note: It is a remarkable fact that, throughout the text, Serres uses several times the althusserian term coupure rather than the expected bachelardian rupture. Whether or not this is done intentionally, the shift is not without significance, since it reflects the temporary re-launch of Bachelard’s endeavour by Althusser in the late sixties, followed by its premature burial. Since, moreover, ‘épistémologie’ had, by the same token, come to mean the very thing althusserians were practising, along with others like Canguilhem, this shift is in part symptomatic of the sceptical stance Serres has come to adopt towards epistemology.]

8. [Editorial note: Here, of course, Serres refers to Althusser and the althusserians.]

[Note by the author.]


11. [Editorial note: viz., science and history of science.]


13. [Editorial note: This is reference to a passage from the Bible, namely in the book of Ruth, chapter II.]

14. [Editorial note: rather than p. 69 = p. 76 of the translation, as indicated in Serres’ text.]

15. [Editorial note: “il” in Serres’ text (« Peut-être il est commis pour assouvir le narcissisme... ») can, by virtue of the pejorative meaning in the context, only refer to “le pire,” “the worst,” in the previous sentence.]

16. [Editorial note: this refers to the third stage of the third partition referred to in note 6, i.e., to the third type of ‘soul.’]

17. [Editorial note: see note 12.]

18. [Editorial note: a fictitious esoteric order and abbey, invented by Rabelais in Gargantua, carrying the motto “Fais ce que vouldras”: “Do as you please.”]

19. [Editorial note: Quirinus is the Roman god, who forms a triad with Mars and Jupiter, that embodies sovereignty, struggle and production. Throughout his work, Serres regularly refers to this triad, when it comes to his critique of the objectionable face of science and, more generally, of practices of dominance and violence.]
In this contribution, I would like to elaborate on some aspects of the work that resulted from the encounter of the copper engraver Albert Flocon with the philosopher of science Gaston Bachelard. The two met each other in the art circles of Paris they both frequented after World War II. In the decade that followed, they collaborated in the production of a number of artistic books, to which Flocon contributed the engravings which Bachelard accompanied or introduced by shorter or longer texts. The present text revolves around a single copper engraving. The engraving opens a cycle comprising fifteen large-format coppers engraved by Flocon complemented by “stories” by Bachelard.‘The cassette was printed in two hundred copies in 1957 under the title *Châteaux en Espagne* and distributed among the members of the Cercle Grolier, a group of “friends of the book.” Bachelard understood his texts as stories of a particular kind. His remarks, as well as Flocon’s engravings, can be regarded as experiments in imagination. And as such, they share a characteristic feature of experimentation: a fundamental dialectic between abstraction and concretion. This motif is the topic and leitmotif that runs through the present paper.

“THE SPACE-TIME OF THE PROJECT”

Bachelard has the following to say on the time of the gestation of this book: “How many stories did I tell to myself during this long winter, when Albert Flocon
brought to me, week after week, the loose sheets of this album!” As testified by the signature dates of many of these coppers, Flocon had engraved them in the course of the years between 1952 and 1956. Now he put his cloud-castles together, presented them to Bachelard one after the other, who provided them with a brief or more extensive text, and the printed book was finally delivered to its subscribers early in 1958. As already on the occasion of the publication of Paysages, their first big common artistic publication endeavor dating from 1950, Bachelard again refers to a peculiar space of resonance in which the philosopher and the artist did not seek a common understanding discursively, but rather indulged in each other’s images and texts in a sort of tacit complicity. Indeed, according to Bachelard “Flocon never explained to me what he wanted to make. From him to me, there was no discourse.” The stories mentioned in the quote above were the ones Bachelard had told himself in front of the images. In turn, Flocon had created his castles in the air stimulated by the rêveries that Bachelard published on the “elements” of fire, air, earth and water in a series of books between the late 1930s and the late 1940s, which had prompted the artist to get in touch with the philosopher.

From the very beginning of his introduction to the volume, Bachelard spells out what fascinates him with these images: “I love the engraving for the engraving’s sake, the autonomous engraving, the engraving that originally illustrates nothing and which I, in my philosophical musings, call the auto-eidetic engraving. For me, it is the ideal of a story without words, narrative in condensed form.” It is clear that the engravings neither refer to a beyond to which they might give shape, nor do they tell a story in the sense of a report of something they refer to. They have their narrative capacity in themselves, in the multiple options to relate their elements to each other. “All ‘castles’ of Flocon glow,” Bachelard states. They shine from within. They are suggestive of their own possible continuations.

Along the same lines, Flocon once confessed: “I had always a predilection for construction sites that show buildings in the making; throughout my life […] I have built air-castles.” In this way, the movement of production in its own right, in its capriciousness, and in its autopoietic reflexivity, is foregrounded and experimentality becomes the central concern of the imagery. Bachelard summarizes the basic idea of the series as follows: “Flocon calls his collection: Châteaux en Espagne. He thus invites us to measure the distance between what one sees and what one dreams, to traverse what could be called the project-space, to live in the space-time of the project. With this formula, the inveterate philosopher that I am,
resumes Flocon’s vision: Flocon is the engraver of the space-time of the project.”

Projecting, in the strong sense of the term—not in its degenerated usage in today’s prose of scientific project application—is a form of giving way in which the path itself becomes thematic and with that, problematic. Bachelard again: “He [Flocon] loves it to catch that moment of the construction in which the construction is just about to engage with the project.”

For those familiar with the epistemological œuvre of Bachelard, a comparison suggests itself here. In his Nouvel esprit scientifique, the book conceived as the manifesto of a non-Cartesian epistemology in the early 1930s, we can read the following sentences: “Above the subject and beyond the object, modern science is based on the project. In scientific thought the subject’s meditation upon the object always takes the form of a project.”

The project thus defines a space in-between, a space populated by instruments through which the subject’s meditation becomes a veritable mediation. The point is elaborated a couple of pages further on: “A truly scientific phenomenology is therefore essentially a phenomeno-technology [phénoménotéchnique]. Its purpose is to amplify what is revealed beyond appearance. It takes its instruction from construction.”

In other words, technique and phenomenon are mutually shaping each other in the process. According to Bachelard, the project also characterizes the very gesture of the modern experimental sciences. Likewise, the tentative, the reaching out by groping, as Sandra Pravica has beautifully put it, is also the founding gesture of Bachelard’s own philosophy of science. It is this very gesture that opens a new space for the game of abstraction and concretion and with that, throws light on the scientific as well as the artistic production process. Last but not least, it elucidates a philosophy of science conceived of as a non-Cartesian epistemology. The phenomenological here has to be taken in its own exposition, neither as a symptom of, nor as a veiling of an essence. The point is no longer to seek behind the appearances for hidden depths. Everything depends on what lies in plain sight and in between, not what is hidden beneath. Thus Bachelard comments on Flocon’s engravings: “The secret of the richness of the narrative that is enclosed in each of these plates lies in the fact that our engraver is a master of simplicity. If behind a bustle of contours and shades one would have to search for a hidden value, if one would have to dig in order to find, then one could take this as an explanation for the possibility of different and changing interpretations. One could be proud to detect some hidden meaning.”

But this is not the point here. The possibility space of these engravings is not vertically, but horizontally organized. Consequently, Bachelard continues: “Here, everything is simple, everything is plain, everything is engraved. Flocon instinc-

50 · hans-jörg reinberger
tively commands the fantastic *plurality of the simple*."

**LA BOUTEILLE: THE FIGURATIVE AND THE NON-FIGURATIVE**

It is now time to have a closer look at one of these copper engravings. Let us concentrate on the first, page-filling Spanish castle of the collection. The index lists it under the title of *La bouteille*, and Bachelard characterizes his remarks as a "philosophical narrative of the bottle". Further on in the text that accompanies this gravure, he addresses it as a "cosmic bottle," and indeed, something solemn, if not sublime, appears to surround this vessel. However, to read the picture in a simple symbolical fashion, for example, the church as the figment of an imagination led astray by obscuring powers—would carry us completely on the wrong track. A flat reading is required, not one leading into symbolical depths.

Geometrically, the image is dominated by the austerity of the vertical and the horizontal. Before a low horizon, the curling waves of a moving sea spread out. On the shore in the foreground to the right, a structure strains upwards that is wrapped in the contours of a bottle and appears to soak up the sand that the waters have washed up on the beach. In the foreground of the picture to the left, this upward movement is taken up once more and transposed in a more abstract form. A further leftover of the sea deposited on the shore, a seashell, serves as an ashtray for a cigarette that glows away next to an extinct match and a stubbed-out butt, and whose thin smoke trail moves in parallel to the bottle, straight up, where it finally tilts, separates into different strands, mixes with the clouds, and disappears behind the bottleneck. A drinking vessel finds its place between the seashell and the bottle. On the image, however, no smoker and no drinker are to be seen. The engraver has simultaneously put himself into the picture and erased himself from it via these props of meditativeness. The cloud-castle thus appears fully present as the product of the engraver’s working table and yet as evanescent as the gracefully rising swath of smoke, as haphazard as a bottle post.

Bachelard muses: “Such engravings can perfectly invoke the polemic between the figurative and the non-figurative. If I were allowed to continue in my philosophical language: I would designate such an engraving as abstract-concrete. I connect it to all that I love of the world, the abstract thinking that guides the concrete creation. Let us try to capture in it that unity of the abstract and the concrete at work, that embodiment of the thinking human in a resilient nature, that synthesis of the figurative and the non-figurative.” And he goes on: “Flocon’s prints do not
copy anything; they do not accept the slavery of a figurative art. But conversely, and without contenting himself with a non-figurative art, Flocon visualizes all the irrealities that transcend the real."

This bottle thus packs a punch. Let us first have a closer look at its contours. Its two halves form a strong contrast that takes up the game of horizontality and verticality and reinforces it with the opposition between bright and dark, of day and night, of light and shadow. Surprisingly, the somber part is directed toward the sea, the blazing one toward land. Again and again in this image, we find such unfamiliar and dazzling reversals of conventions. Towards the spectator, the bottle opens and articulates its interior as a lofty gothic cathedral. Its needle-pointed middle tower juts out of the bottleneck, breaking through the image margin. A host of roof workers appears to drive it into the sky. The choir is filled with a radiating statue of a madonna that rises out of a slipstream of little human figures worshiping her and forming her socle at the same time. As soon as the spectator concentrates on the cathedral that delineates itself in the contours of the bottle, the latter appears as “slit open,” as a “provisional scaffold,”\(^\text{20}\) that is in the process of becoming superfluous and of detaching itself like a skin from the building—the frame of a construction site. Its label as well appears to peel from the glass, as if it had lost its readability and with that, its function, in the shining rays cast by the sun on the bottleneck, from where they reflect in all directions. To quote Bachelard on Flocon’s airy castle once again: “Right from the first engraving—the bottle in front of the sea—one experiences these transactions between the function of the real and the irreal, transactions that make up the life of the imagination. As soon as the artist has entered this zone of transaction in which the irreal unsettles the real and the real beguiles the fantastic, it appears as if one could assign the task of creating images to the objects themselves, trusting that the images, in the mode of a rêverie, take possession of the objects, play around the things.”\(^\text{21}\)

With that description, Bachelard captures a basic dimension of Flocon’s work in a precise and pointed manner: It is a sort of leftover of the objects. And although Flocon barely leaves the frame of the figurative, he treats things in such a transfiguring manner that, in the end, it is the power of imagination itself that comes into its own exactly through that excessive precision of the elements that almost invites touching them. There is no representation here, but manifestation, a projection of worlds, and with that, the process of projecting reflexively manifests itself at the same time. And yet, the way in which such heightened awareness is provoked is in itself utterly rare. “Yes, indeed, engraving, and in particular copper
engraving, is an extremely abstract technique,” Flocon once remarked in a conversation with the French writer Gil Jouanard, and he carried the argument to extremes in claiming that the only thing the engraver could have recourse to finally was abstraction.\textsuperscript{22} Thus, these coppers contradict the function of the technique of copper engraving in the pre-photographic and pre-lithographic age, when it was primarily used for reproduction.

\textit{LE RATIONALISME APPLIQUÉ: THE ABSTRACT AND THE CONCRETE}

Flocon also called Bachelard “the man of the abstract-concrete,”\textsuperscript{23} capturing an essential point in Bachelard’s thought, in particular his vision of the contemporary sciences: In his epistemological oeuvre, Bachelard emphasizes the un-eidetic, mathematical apparatus of modern physics, and at the same time its connection with very concrete phenomeno-technical contraptions. As a consequence, it does not come as a surprise when Bachelard, in \textit{Le Rationalisme appliqué}, one of his epistemological books he was writing at the time of his encounter with Flocon, explicitly characterizes the physics of his time as an “abstract-concrete mentality” that realizes itself in a permanent “reciprocal action of abstraction and concretion.”\textsuperscript{24} These attributions are not meant to be states of mind or states of the matter. Rather, they must be understood as process categories that characterize the activities within a “field of thought” \textit{[champ de pensée]} that emerged, as Bachelard put it, from the “conjunction” of mathematics and experiment\textsuperscript{25}: “No empty rationality, no incoherent empirism—these two philosophical promises are at the bottom of the tight and precise synthesis of theory and experience in contemporary physics.”\textsuperscript{26} And Bachelard returns to his earlier remarks on the relation between subject and object in his \textit{New Scientific Spirit} of 1934 when he now states: “It is no longer a question of confronting a lonely spirit with an indifferent universe. From now on, one must act out of that center in which the knowing mind is determined by the respective object of his knowledge, and from where the former in return directs experimentation with even greater precision.”\textsuperscript{27} Bachelard’s German contemporary Ernst Cassirer once quoted Werner Heisenberg to make the same point about this intimate connection in modern physics. “The modern theories,” according to Heisenberg, “did not issue from revolutionary ideas that would have been brought into the exact natural sciences from the outside. [...] The change in the foundations of exact natural science as it happened in modern physics has been compelled step by step through experimental investigations.”\textsuperscript{28}
What Bachelard chiastically calls “applied rationalism” and “instructed materialism” form the two inseparable sides of the same coin. “We thus see that we can best assure ourselves of the rational properties of a technical materialism, and reciprocally, the real properties of an applied rationalism, if we bring reason and scientific object systematically into a dialectical relation with each other.” For the scientist this means: “When it comes to assure oneself of an object of scientific knowledge, one can no longer entrust oneself to the immediacy of a non-ego opposing an ego. [...] The rationalist cogito [...] has to function like an emergence out of a more or less empirically corroborated existence.”

According to Bachelard, an epistemological reflection on the dynamics of the sciences must not eschew that dialectic; on the contrary, it must endorse it. Consequently, Bachelard sees his own philosophy of science as a “philosophy at work” [une philosophie au travail], and he contrasts it with what he criticizes as the “philosophies of summary” [philosophies de résumé] of his predecessors and contemporaries in philosophy of science. And he does not exempt the historians of science from this critique, reproaching them to shy away all too often from a reconstruction of the obscure situations in the course of knowledge acquisition, those situations in which the abstract and the concrete, concept and object have not yet found—or have momentarily lost—their recursive connection. In contrast, Bachelard claims to proceed as process-oriented and tentative at the level of epistemology, as he perceives the sciences to do in their own work. In his view, this is what any epistemology should take as its starting point. From here, his epistemology takes its peculiar historical shade. “Epistemology has thus to be as mobile as science itself.” If, for the physical sciences this means that “each new experiment exposes [...] the very method of experimentation to experience”—that is, to testing -, then it means for the epistemologist that he, “in order to understand, must participate in an emergence.” In other words, no prima philosophia, no “philosophy of the beginning”, but rather a “philosophy of continuation.” Like the scientist, the epistemologist has to immerse himself into a recursive process; his epistemology can no longer rest on Cartesian principles.

EXPERIMENTATION: A DIALECTICS OF NATURE AND COUNTER-NATURE

Let us go back to Flocon. We can assume that Bachelard saw Flocon’s craft of copper engraving as immersed into a phenomeno-technical process, that in some respects resonates with the scientific process of knowledge acquisition. Just as
modern physics is “no longer a science of facts, but a technology of effects,” a science that no longer summarizes itself in “description of phenomena, but rather in a production of phenomena”, the work of the engraver inscribes itself into a comparable space, the space of a “dialectics of nature and counter-nature,” of the figurative and the non-figurative, the real and the unreal, to refer back to Bachelard’s story about the bottle. This space corresponds to what Bachelard calls an “intermediary time,” a “time of the in-between.” Each of these castles invites us, as he puts it, to “live in the space-time of the project.”

Repeatedly, Bachelard comes back to this aspect of intermittency, a time discon-
nected from a beginning and an end, as one could put it. And it is exactly this limbo that creates the possibility of what he calls, at the level of narration, a “con
tingency of contemplation.” “I tell myself a different story from the one I told myself yesterday. Sincere contemplation is a capricious thing—pure caprice, in fact.” And to reverse once more the register of the crafts in the other direc-
tion, Bachelard sees the scientist in a comparable situation when faced with a complex reality. In the sciences as well, an object can “command several types of objectification, several perspectives of specification, and it can be part of different issues.”

“I loved it to push rationality to its limits,” Flocon once confessed, and he added: “Beyond that, there is still enough of a mystery.” The gesture of the experiment-
er cannot be better expressed than with these words. The experimenter sharpens and configures the available knowledge in such a way that it becomes possible to push beyond it. Flocon understood copper engraving as a form of experimenting. That is not to be understood just in the sense of probing, of trying out. For sure, he also played with the printing techniques and materials, and in particular has transferred worn copper plates into new contexts of printing. But here, some-
thing else is at work and at stake. What we are facing is the fundamental gesture of creating a surplus by omission, in other words, of concretion by abstraction. From the constraints of the technique, things hitherto unheard and unseen emerge. The technique does not exhaust itself in the reproduction of something given, rather it provokes potentials intrinsic to the objects with which it interacts, thus leading to something like an immanent transcendence. The experimental structure is that of a project. It is this gesture of pointing beyond, not in the sense of an overarch-
ing classificatory subsumption or generalization, not in the sense of a replacement by a mere other, but rather in the sense of a transgression through restriction, that constitutes the decisive aspect of experimentation. Here, the experiment ap-
proximates with what it means to be exemplary. An experiment is always exemplary in character. The experiment presents a peculiar kind of vicariousness. It does not just stand in for something. It points beyond itself in that it points to its own specificity. It is a hypostasis. It exposes.

Experimenting is the craft and the art of the abstract-concrete. From this vantage point, Bachelard saw Flocon’s engravings as a relentless effort to abstract from the concrete and at the same time to concretize the abstract. Consequently, he addressed Flocon’s airy castles as “abstract-concrete plates”. Like he was interested in the “real” of the sciences [le réel scientifique] rather than in the representations that they offer, in the “real” of literature rather than in the tales that it tells, so he was interested in the “real” of Flocon’s engravings, not in their possible representations. What fascinated him was their auto-eidetic potential of iteration.
NOTES


27. Bachelard 1949, p. 4.


34. Bachelard 1949, p. 43.
35. Bachelard 1949, p. 11.
40. Bachelard and Flocon 1957, p. 12.
42. Bachelard and Flocon, p. 9.
43. Bachelard 1949, p. 53.
44. Flocon 1983, p. 64.
1. INTRODUCTION

The work of Michel Serres, if considered at all, is often presented as a radical break with or criticism of the work of Gaston Bachelard. This is sometimes also endorsed by Serres himself, who in an interview stated:

Yes, I wrote my thesis under Bachelard, but I thought privately that the “new scientific spirit” coming into fashion at that time lagged way behind the sciences. ... The model it offered of the sciences could not, for me, pass as contemporary. This new spirit seemed to me quite old. And so, this milieu was not mine.¹

Bruno Latour, in a similar vein, has described Serres as the anti-Bachelard.² Within this context the project of Bachelard is described as a naive belief in the rationality of science or as a misguided project to purify science from all non-scientific elements. For instance, in his own work, Latour, inspired by Serres, uses Bachelard as the perfect illustration of the paradox of modernity he is attacking:

Gaston Bachelard’s dual enterprise—which [...] exaggerates the objectivity of the sciences by dint of breaking with common sense, and symmetri-
cally exaggerates the objectless power of the imaginary by dint of epistemological breaks—offers the perfect symbol for this impossible crisis, this drawing and quartering.3

This image, however, is too simplistic and in fact makes us unable to really appreciate what we can learn from the work of Bachelard today. As Christiane Frémont correctly notes, “from a genuine post-bachelardian one has too hastily made Michel Serres into an anti-bachelardian.”4 A more interesting picture comes forward if one goes beyond such a simple but radical opposition between Bachelard and Serres. Instead one could focus on a few, but essential continuities between both authors.

Precisely by focusing on Serres’s interaction with Bachelard in his early work, a core element of the Bachelardian project that is still at work in Serres’s philosophy and remains relevant for contemporary discussions will be highlighted. This does not mean that Bachelard and Serres fundamentally agree on many let alone all topics. On the contrary, clear differences must be recognized, for instance how Serres has developed a radically different ontology focused on the role of objects. This paper thus deals most of all with the early Serres, without discussing his more recent positions and his general ontology of quasi-objects in detail. The aim is rather to understand how Serres’s break with Bachelard and French epistemology in general was produced by an intimate dialogue with this tradition.5

In this paper, the claim is precisely that clear disagreements concerning topics such as rationalism or the role of objects do not contradict a certain methodological continuity between both authors. It is this methodological aspect of Bachelard that, by still being at work in Serres’s philosophy, remains relevant today. In the first part, I will discuss the case of Gaston Bachelard, especially his surrationalism and his philosopie du non. Secondly, I will use this reading of Bachelard to shed a new light on the specific criticisms Serres raised against him. The claim is that, instead of abandoning Bachelard’s perspective, Serres’s criticisms, even when one acknowledges clear discontinuities in content, can be understood as a radicalization of certain methodological elements at work in Bachelard.

2 THE PHILOSOPHY OF SCIENCE OF GASTON BACHELARD

There are many different possible attitudes in the philosophy of science. To grasp what is specific to Bachelard’s, it is useful to contrast it in a rather schematic way
to how philosophy of science is traditionally understood. If one refers to historical examples such as Logical Positivism and its attempts to promote verificationism or confirmation theory, philosophy of science seems to be about formulating criteria for how science is a rational process. Bachelard’s project is, however, different in several respects. First of all, projects such as Logical Positivism aim to conceptualize a timeless model of science, i.e. a model that would work for any specific moment in science whatsoever. Secondly, their aim is to propose norms for how science should behave rather than how it factually behaves. In this sense the philosopher has the task of dictating to the scientist how to do science.

2.1 Surrationalism and the primacy of science

The program that we can find in Bachelard is rather different. Its aim is similar in the sense that it wants to understand scientific practices, but it must be seen as part of a bigger project, namely trying to understand how human rationality works by ‘writing the history of the mind.’ In fact, in twentieth-century France there was hardly a distinction between philosophy and history of science in the first place. Rather, they have always been intimately related to one another. Central to philosophy of science in France is the idea that to understand the rationality of science and the functioning of the human mind, one cannot start from the traditional a priori way. One always has to look at the history of the sciences to see the rational movement of thought.

An important reason why such authors as Bachelard follow this approach, must be linked to the foundational crisis in mathematics and the scientific revolutions in physics at the beginning of the 20th century. For many philosophers these crises showed that the traditional assumption of an atemporal and ultimate foundation for knowledge and rationality was not so self-evident. How can we still be sure that our beliefs are rational if there can be such historical breaks and revolutions even in mathematics or physics? Projects such as Frege’s or Russell’s Logicism or Husserlian phenomenology can be understood as responses to these crises and attempts to find new firm foundations for all rational beliefs.

Following Castelli Gattinara, one could state that in France a different approach was taken. Rather than trying to look for a firm foundation underneath the dust of scientific revolutions, authors such as Bachelard claimed that rationality was to be found within the revolutionary act itself. Instead of seeing historicity as a problem for rationality, it was seen as the ground for rationality itself: science was rational.
not despite its historical shifts, but because of the historical shifts, which were
deemed to be rational stages of scientific thinking.\textsuperscript{10} Exactly, the dialectics of the
history of science proved the sciences to be rational.

Now, in the case of Bachelard this is argued for in the name of an ‘open rational-
ism’ (\textit{rationalisme ouvert}) or what he calls a \textit{surrationalism}.\textsuperscript{11} For Bachelard rational-
ism does not imply that one should start from a number of fixed cognitive
categories. The latter he calls a ‘closed rationalism,’ where the forms thought can
take are fixed for eternity and in fact limit the way we can think and do science.
One could think of a simple Kantian scheme, where rationality is defined by time-
less categories of understanding. An open rationalism, on the other hand, starts
from the idea that the act of rationality lies within the overcoming of the catego-
ries of thought by creating novel ones, if deemed necessary by the developments
of science. Bachelard argues to

place reason \textit{inside the crisis}, to prove that the function of reason is to pro-
voke crises and that the \textit{polemic reason}, to which Kant had only attributed
a subalternate role, cannot leave the \textit{architectonic reason} with its contem-
plations. We should thus gain access to an open Kantianism, a \textit{functional
Kantianism}, a \textit{non-Kantianism}, in the same way as one speaks of a non-
Euclidian geometry.\textsuperscript{12}

In this sense, similar to the subversive nature of surrealism, \textit{surrationalism} aims
to break with conservative tendencies to stick with old categories of thinking.
Surrationalism precisely creates the room for scientific practices to redefine our
cognitive categories. For Bachelard “science instructs reason. Reason has to obey
science, a more evolved science, an evolving science.”\textsuperscript{13} Thus we find in Bachelard
the distinctive idea of the \textit{primacy of science over philosophy}: philosophy should
not dictate or supervise a normativity of science, but rather learn from the norms
internal to the sciences themselves.\textsuperscript{14}

Against the closed rationalism of the philosophers, Bachelard aims to mobilize an
open rationalism. This openness, however, is not found within traditional philo-
sophical activity, but within the scientific practices. As a consequence, there ex-
sts a broader tension between philosophy and science within Bachelard’s oeuvre.
For him, scientists continually revise their own categories, while philosophers
tend to be conservative about them.\textsuperscript{15} Philosophers wrongly try “to apply neces-
sarily finalist and closed philosophy to open scientific thought.”\textsuperscript{16} For Bachelard,
the sciences never follow the clear-cut and given philosophical categories. Rather they create their own novel categories because “science ordains philosophy by itself.” 17 Or as he states, “[e]very philosophical mind who puts himself in studying science would see how much of contemporary science is philosophical in its core.” 18 Given philosophical categories are in fact never a solution, but always a problem. This is related to Bachelard’s idea that the formation of the scientific mind consists in an epistemological rupture with everyday experience:

We believe, in fact, that scientific progress always shows itself in a rupture, in continuous ruptures, between ordinary knowledge and scientific knowledge, as soon as one is faced with an evolved science, a science which, due to the these ruptures themselves, carries the mark of modernity. 19

This break implies a break with psychologically tempting images about the scientific object, but also with spontaneous philosophical theories about science. “The scientific mind consists precisely in the bracketing of the first philosophy [la philosophie première]. Just as the experimental activity, the philosophy linked to the scientific activity must be nuanced and, as a consequence, be mobile.” 20 But traditional philosophy of science does not do this, and therefore “science does not have the philosophy it deserves.” 21 And this is precisely what Bachelard aims to create in his own work, a surrationalism respecting the openness that is active within scientific practices. In this sense, “epistemology must thus be as flexible as science.” 22 The implication is that to really grasp what is going on in scientific practices, looking at the history and development of these sciences becomes a necessity.

In this section we have seen that for Bachelard the relation between philosophy and science is mainly described in a negative way: one should follow the sciences and rather than starting from some given philosophical assumptions, but search for the currently adequate philosophical categories within the sciences themselves. The results depend on the specific scientific field under consideration. Which philosophical categories the philosopher ends up with, depends on the field or even the concept in question.

In this sense, the lesson to be drawn is methodological: the concepts must be the product of the historical data, rather than the other way around. In this way it is a plea for a genuine conceptual flexibility in philosophical categories. Moreover, in order to do this the philosopher can rely on the philosophical activity at work
within the sciences themselves. Not only will this allow the philosopher to better understand the historical case studies he or she is examining, but “we believe rather that it is at the level of particular examples that philosophy of science can give us general lessons.”

2.2 Scientific practice and philosophie du non

At the same time, however, there is a clear normative idea of scientific progress at work in Bachelard’s work. One of his central starting points is that within history of science it is always inevitable to make normative judgments from the present perspective. In this respect, Bachelard contrasts the work of the epistemologist with that of the common historian. The historian looks for facts, and accumulates them in his study without making any normative judgment. This model, however, does not work for the history of science, because “it does not take into account the fact that every historian of science is necessarily a historiographer of Truth [de la Vérité]. The events of science are connected in an ever-increasing truth.”

According to Bachelard, such normativity is necessary and meaningful. He acknowledges that reading the history of science as a teleological process, where historical episodes must be seen as necessary steps or obstacles with the present as their goal, is problematic. But he distinguishes this from the claim that if one wants to do proper historiography of science it is unavoidable to rewrite the history of science from what is presently seen as scientific and what is not.

At the same time, however, there is a clear notion of historical discontinuity about science in Bachelard’s oeuvre. This is the famous epistemological rupture mentioned above. This rupture not only implies a break between spontaneous and scientific concepts, but also historical breaks within the sciences themselves. Claiming that the scientific revolutions at the beginning of the 20th century imply a ‘new scientific spirit,’ Bachelard argues that there exists a radical discontinuity between Newton and Einstein. “One thus cannot correctly say that the Newtonian world prefigures in its main lines the Einsteinian world.”

At first sight the combination of such a normative framework and historical discontinuities seems problematic. How can contemporary scientific categories be relevant to a past with which scientific practices have broken? Both elements, however are not irreconcilable for Bachelard, but precisely imply each other if one understands what scientific progress is all about. In his book Philosophie du non
Bachelard argues that historical progress in science is not made in a continuous manner, but rather through breaks. As stated above, it is precisely in these historical shifts that the scientific mind shows its rationality. But the products of these shifts as well have a specific character, that Bachelard tries to capture through his ‘philosophie du non.’

For Bachelard, the sciences progress through a model of incorporation: there is a radical shift in scientific revolutions, but one where the previous theories are not completely abandoned, but rather reappraised and translated into particular and approximate cases of the new theories. “The philosophie du non will therefore be not an attitude of refusal, but an attitude of conciliation.”27 The example he uses is that of non-Euclidean geometry, which never disproved classical Euclidean geometry, but reappraised it as a specific case of a broader framework. “The generalization by the no must include what it denies. In fact, the whole rise of scientific thought in the last century has come from such dialectical generalizations resulting in the incorporation of what one denies.”28 It is in this manner that he speaks of quantum mechanics as a non-Newtonian physics and of his own epistemology as a non-Cartesian epistemology.29

The history of science, thus, follows a progressive dialectical movement, which is fundamentally open-ended. The epistemologist must follow and grasp this movement. “The progress is the dynamics itself of scientific culture, and it is this dynamics that the history of science must describe.”30 For Bachelard this results in a distinction between lapsed history (histoire périmée) and sanctioned history (histoire sanctionnée). Since the history of science is not continuous, but cumulative, this implies also the dismissal of certain parts of science. The former is therefore used as a term for these parts of science that, from the contemporary perspective, are excluded as non-science, while the latter refers to those elements that are preserved.

Bachelard thus endorses a specific form of ‘presentism.’31 Such a normative presentism is quite problematic for many contemporary historians of science and will also be heavily criticized by Serres. However, I want to argue that in the light of Bachelard’s surrationalism, Serres’s critique should not be understood as a radical break with Bachelard, but rather as an internal dispute about this methodological principle: is Bachelard’s presentism not in conflict with the very idea of the openness of surrationalism?
But to see why Bachelard endorses this presentism, one must situate it in the light of the other goals of his philosophy. First of all, as stated above, the goal of French epistemologists such as Bachelard is broader than history of science, but implies the writing of a history of the rational mind. The main objective is not just to grasp specific historical facts, but rather the above mentioned surrationalism and the flexibility of the mind. Secondly, for Bachelard there is also a clear pedagogical task present in its philosophy of science. Describing the struggle of past science with certain epistemological obstacles, such as ordinary experience and naive philosophical theories, is necessary in order to prevent new students of science from possible missteps, confusions and false theories. History of science, for Bachelard, therefore is not only valuable per se, but serves the “formation of the scientific mind.” It is therefore also insufficient to write a so-called ‘Whiggish’ history of science, where the past works teleologically towards the present (let alone see Bachelard’s own project as an example of this). Such an approach fails to appreciate how contemporary scientific theories are not self-evident, but imply certain breaks with ordinary experience and spontaneous philosophy.

3. MICHEL SERRES’S CRITIQUE OF BACHELARD

In the previous sections we saw how Bachelard conceives of the relationship between science and philosophy. Now that Bachelard’s approach has been made clear, we can reexamine the case of Michel Serres and see that the picture of Serres as an anti-Bachelardian has its limits. On the contrary, this reexamination will allow us to stress some interesting continuities at work between the two, hidden beneath the more visible disagreements.

Although relating both authors is not self-evident, there are in fact several similarities to pinpoint. But before going into that, first the question must be raised what precisely is meant with the claim that Bachelard has influenced Serres. This claim might first of all mean that Serres’s early philosophy has been greatly shaped by the way philosophy of science was taught in the 1950s. The way philosophy of science was conceived in France at that time was indeed strongly defined by the work of Bachelard. The typical combination of philosophy and history of science, for example, is found in both authors. But also a clearly constructivist perspective can be found in Bachelard as well as in Serres, focusing not on how the scientist passively studies nature, but rather on how (s)he actively intervenes in nature and ‘constructs’ the phenomena.
Serres might thus be Bachelardian in a rather indirect way, namely through the intellectual climate or through other French historical epistemologists such as Georges Canguilhem, or even through the work of Louis Althusser and Michel Foucault. But Bachelard himself in particular played a more prominent role, besides being the reference point within discussions about philosophy of science in France. Serres himself was (a) first of all a direct pupil of him, since Serres “wrote [his] thesis under the direction of Bachelard, on the difference between the Bourbaki algebraic method and that of the classical mathematicians who had gone before.” Moreover, (b) Serres discusses Bachelard extensively in his early work, and even in later interviews concerning his philosophical influences. The result is then also that (c) several key concepts were developed in direct dialogue with Bachelard himself. It is for these reasons that it seems warranted to speak of the Bachelardism of Serres.

Besides such simple continuities there are, however, more substantial links in methodology to highlight. For instance, following new developments within physics, Serres develops a non-determinist physics, where the starting point is not order but disorder. Clearly, this is in fundamental disagreement with how Bachelard understood physics. However, at the same time this can be seen as a next step in the Bachelardian conception of the development of science, namely that of the above philosophie du non. Similar to how Euclidean mathematics became a borderline case of non-Euclidean mathematics, Serres develops a perspective in which the old physics is an exceptional case in a broader framework where disorder is the rule. “Order is not the norm, but is the exception.” Or as Ilya Prigogine and Isabelle Stengers comment on Serres’s philosophy: “There are the rare ones in which determinism exists as a limit-state, costly but conceivable, in which extrapolation is possible between the approximate description of any observer and the infinitely precise one of which Leibniz’s God is capable.” The philosophie du non can thus be found in Serres’s reading of contemporary history of science as well. Even though Bachelard and Serres clearly disagree on the content, on a methodological level Serres’s distinct view on physics can be seen as loyal to the Bachelardian framework.

Even more telling, however, is that not only the philosophie du non, but also Bachelard’s surrationalism is recognizable in Serres. To dig up this similarity, let’s take a closer look at what Serres is criticizing Bachelard for:
Yes, I wrote my thesis under Bachelard, but I thought privately that the “new scientific spirit” coming into fashion at that time lagged way behind the sciences. Behind mathematics, because, instead of speaking of algebra, topology, and the theory of sets, it referred to non-Euclidean geometries, not all that new. Likewise, it lagged behind physics, since it never said a word about information theory nor, later, heard the sound of Hiroshima. It also lagged behind logic, and so on. The model it offered of the sciences could not, for me, pass as contemporary. This new spirit seemed to me quite old. And so, this milieu was not mine.

At first sight, it seems that, according to Serres, the whole idea of Bachelard, that in contemporary physics there is a new scientific spirit at work which calls for revisions in philosophy is problematic. Talking about such an epistemological break, as Bachelard tends to do, is not the right approach. But if one looks closely, Serres is not claiming that there have been no shifts at all that call for our philosophical attention. Rather, he seems to claim that Bachelard is lagging behind the newest developments, since in mathematics for instance, “instead of speaking of algebra, topology, and the theory of sets, it referred to non-Euclidean geometries, not all that new.” The problem is not that Bachelard claimed that there was an epistemological break, but that he did not see all the breaks, or the newest ones. In a way then, we could say, Serres accuses Bachelard of not being bachelardian enough, of not being loyal enough to his surrationalism.

Taking this surrationalism of Bachelard as a starting point, the three main criticisms of Serres to Bachelard can be reexamined. The first criticism is already hinted at above, namely that Bachelard did not live up to his own standards, because he had not followed the most recent scientific developments that Serres himself witnessed. “I had the chance to witness, in real time, three or four big scientific revolutions: modern mathematics, biochemistry, information theory and, later on, in Silicon Valley, the digital one.” Not only does Serres want to open up this epistemological project even further, but he also aims to write about a new scientific spirit "nouveau nouvel esprit scientifique." Serres claims to follow the sciences even more closely, radicalising a flexibility that even Bachelard lacked. Secondly, these new developments in the sciences result in a shifting role for the philosopher, since the new sciences produce their own internal epistemology. Finally, the problem is not only that the philosopher cannot be an epistemologist anymore, but also that by trying to be merely an epistemologist, he or she misses the whole political dimension of science. Epistemologists such as Bachelard failed...
to hear “the sound of Hiroshima” and Serres tries to correct this. Although these three criticisms seem quite radical, they can, however, all be seen in the light of a surrationalist move. In this sense, the claim can be defended that precisely in criticizing the content of Bachelard’s project, Serres remains loyal to its methodology.

3.1 A new new scientific spirit

As was clear from Serres’s description, Bachelard’s epistemology is not yet open enough and in the end reduces science to practices that have to wait for an epistemology to speak out their truth. In that sense, Serres’s early work consists in a correction of this element within the Bachelardian project. Serres considers himself well-placed and even obliged to describe this new new scientific spirit because his own training came not from philosophers, but “consisted in witnessing—almost participating in—a profound change in this fundamental science” while “the epistemologists didn’t follow.”

This new new scientific spirit is mainly inspired by information theory, topology and mathematical structuralism. According to Serres it consists in an ontological shift, resulting in a new ontology that will also prove to be fundamental to his later philosophy. It leads to a worldview where not only humans possess and transmit information, but where this can be generalized to all possible relations and objects:

There is a constant and continuous dialogue between things which form the historical fabric of events and laws, among whom my intervention is exceptional [...] The general informational language is the fundamental and continuous relation between objects. Even before their deciphering, the certainty that it exists induces the certainty that the external world exists, in the mode of a communicating network, of which all the networks I know and could constitute are singular, exceptional cases, approximating to imitate the real world.

Secondly, following the generalization of this ontological claim, Serres also problematizes Bachelard’s profound distinction between science and culture, the rational and the imaginary. Inspired by the promises of structuralism, Serres seems to ask: a new method is made possible, one that “excludes nothing; better yet, it attempts to include everything [...] So why would I exclude literature?” Only an a priori distinction can prevent us from making this move, a criterion imposed by
philosophers from the outside. Again, however, it is by simultaneously dismissing the content of Bachelard’s point of view, but radicalizing his methodological principle that we get there.

At several moments, Serres portrays himself as the next step in completing Bachelard’s work. In the first book in his *Hermes* series, Serres labels Bachelard as the last of the classical projects in literary criticism and the first of the structuralist ones: “the contemporary idea of critique defines itself relatively easily as a passage to the limit of the Bachelardian incompleteness.”46 Starting as it does from the opposition between symbolic analyses of images and rationalist studies of truth, Bachelard’s double oeuvre is portrayed as the radicalization of this distinction to the moment where it implodes: the symbolic analyses of the most abstracts myths, namely the archetypes of nature (fire, water, earth, air). The study of the imaginary then implies a natural history and the study of science a psychoanalysis of images. “To a false (and original) alchemy correspond true dreams, to a true (and actual) chemistry correspond false images.”47 Bachelard is the first to combine both projects in one philosophy, but they remain irreconcilable.

Very similarly, in his second *Hermes* book, Serres describes a three stage process: from the subjective-subjective stage of Descartes, through the subjective-objective stage of Bachelard to the objective-objective stage of the new new scientific spirit.48 Serres starts from the ‘wax’ example of Descartes, which is subjective-subjective for him since both the sender (the wax) and the receiver of information (the cogito) possess no fixed and objective information, but rather information that is unreliable and ever changing for Descartes. For Bachelard, on the other hand, the world is an undetermined realm of complexity and it is the subject that aided by concepts plus a *phénoménotecnique* imposes a certain rigor and thus reliable information on the object. By purifying it from the subjective images related to color or smell, one makes objectivity possible. However, in the light of the above mentioned ontological shift, the new new scientific spirit goes one step further and is objective-objective, since both the one who studies and that what is being studied can possess, transmit and receive real and reliable information. “The third stage, one must call objective-objective, since it tends to decipher the language that objects apply to objects, by reconstituting, when it is possible, the objective language.”49 This real information is not limited to the rational side, purified from subjective experiences, but rather consists of both primary and secondary qualities in the object as well as in the subject. One returns to the things themselves; a stage where history and physics, culture and science become one.50
The new new scientific spirit thus results in one method to study science and culture rather than in two separated methods. This leads to the typical Serresian readings of authors such as Jules Verne or Émile Zola, in whose work Serres finds the genesis of contemporary scientific theories such as thermodynamics. It is also in this context that one should understand Serres’s suggestion that “the most scientific works, most instructed works of Bachelard, would they be concerned with the poetic elements? Would we find here written, through a method of negation and denial, the prophecies of the new new scientific spirit?” According to Serres, hidden within the books concerned with the imaginary, Bachelard opens up a perspective that articulates how the material things can impose their information on our minds. Our imagination must therefore not be seen as independent of the world, but rather as part of and in relation to the networks of the world.

However, it is important to note that the claim is not that Zola, for instance, was equally or even better aware of scientific developments than the scientists. Rather, the idea seems to be that one cannot start from a clear distinction between science and culture, but should be as flexible as the texts themselves. Scientific theories and ideas can be developed within literary texts as well. Not because there is a hidden layer of scientificity in these texts, but rather because both are part of one network, that is not fundamentally broken in two.

Neither does this imply some form of radical relativism, where a scientific practice, theory or text is completely similar to mythical, political or cultural texts. This is definitely not Serres’s. He would certainly stress the difference between a scientific practice and other practices, but never in a radical, ontological and a priori way. Claiming that science distinguishes itself by a form of rationalism, even an open one, is already imposing a certain philosophical category on science, namely that of rationality. Instead, Serres wants to separate the question of the rationality of the sciences (which is actually rather an answer than a question) from the underlying question of what one could, following Stengers, call the singularity of the sciences: what is the specificity of scientific practices that distinguishes them from other types of practices? Referring to the rationality of these practices is a possible answer to this question, but one that cannot be given a priori. Instead, one should follow the sciences, even through myths and literary texts, rather than delineating from beforehand what the limits of the sciences are. In this sense there is a clear discontinuity with Bachelard, namely by abandoning the whole notion of rationality. Of the surrationalism, it is the sur-, the open movement that remains at work in Serres, while he abandons the rationalism.
It is in this light that one, thirdly, has to understand the radical shift in how to read the history of science. Serres disagrees with the picture sketched above by Bachelard, that there are clear epistemological ruptures that break with the imaginary part of our thinking and that there is a meaningful distinction to make between lapsed history and sanctioned history. Such an a priori imposing a philosophical dichotomy precludes us from following the sciences in their totality. It prevents us, for example, to see ‘contemporary’ science at work in the work of authors such as Lucretius. In his book on Lucretius, Serres tries exactly to show how his work, often seen as part of lapsed history, has reemerged as relevant for contemporary fluid mechanics. “Scientific modernity does not enter history by a fault or a break, but by the revival of a philosophy of nature that has been spreading ever since Antiquity. The so-called break is an artefact of the university.”

The new new scientific spirit thus results in an alternative epistemology of science, which could be called the model of proliferation. Although we will not go into details, the central idea is that the objectivity and rationality of science is strengthened if it is linked to more elements and connections. Elements of literature and imagination can thus play a positive role in the production of knowledge. This is opposed to the model of purification, ascribed to Bachelard, where science becomes more objective if it is purified from imagination and epistemological obstacles.

But there is an ambiguity here, in the case of Serres. He characterizes science which follows the model of purification as repressive of an original multiplicity. “Let this scientific knowledge get rid of its arrogance, its masterly, its ecclesial dispensation, let it abandon its martial aggressiveness, the hateful pretension of always being right, so that it speaks truth, that it descends, pacified, towards common knowledge.”

At the same time, Serres claims that this multiplicity can be adequately articulated in his own model of proliferation. In his book on Lucretius, for instance, Serres claims that modern physics is closed off in laboratories, while the fluid mechanics found in Lucretius works also outside, capable to grasp the multiplicity of the world itself. His book has indeed been read as “a story in which physics neither represses (through experimentation) nor manipulates nature.” Serres, thus, paradoxically, believes to have found a model that is no model, a model that contrary to all other models does not reduce, repress, push into categories the original multiplicity found in nature.
But such a belief in a ‘model without a model’ seems unwarranted. A more plausible view is to acknowledge that all models imply some form of violence towards their objects, but not all in the same way. The model of purification, thus, can be criticized for implying a repression of the purified phenomena, but the model of proliferation is itself not free from this violence. It (hopefully) implies less violence or violence of a more acceptable sort. But again, to evaluate this, it is probably necessary to relate the issue to the specific phenomena one is talking about. Serres speaks about whirlpools or climate models. For these phenomena a model of purification seems problematic, indeed. But perhaps Bachelard’s model of purification can still be applied to a number of cases, such as quantum mechanics or the theory of relativity. Again, one might mobilize Bachelard’s *philosophie du non*: we can interpret the model of proliferation not as complete dismissal of that of purification, but instead as a model of non-purification, where classical purification remains a limiting case in the broader framework.59

3.2 A new image of the philosopher

The second crucial element is that the new scientific spirit also forces Serres to accept a new role of the philosopher. First of all, Serres introduces a new term to describe the philosopher. The model that Serres prefers is that of the *encyclopedist*, collecting different sciences and types of knowledge, without reducing them or forcing them in a strict hierarchy. Rather they are situated next to one another, with the everlasting possibility of cross-references.60 “Science is, on and for itself, a collection of dictionaries: The Encyclopedia.”61 In this sense, we should correct our claim that Serres follows the model of the *philosophie du non*. The model of the encyclopedia is a different, yet radicalized version of the *philosophie du non*. First of all, in the sense that, although regional rationalisms are clearly also present in Bachelard, in the case of Serres these regional criteria for knowledge and truth are also internally developed by the sciences rather than conceptualized by epistemology (see below).62 Secondly, the model of the Encyclopedia starts from a different image than that of conciliation and dialectics. “The new spirit focused itself in a philosophy of no; the new new spirit develops itself in a philosophy of transport: intersection, intervention, interception.”63 Again information theory is the paradigm here, for instance in the case of molecular biology. What molecular biologists show is that in genetics one should not search for the ‘noumena’ underlying our biological beings, the invisible behind the visible, but rather the universality of the genetic code.64 Notions from information theory are thus translated, and at the same time transformed, when applied to a different scientific region,
in this case biology.

The encyclopedist, moreover, is not just the Bachelardian epistemologist updated by insights from the contemporary sciences. There is a second and more important revision at work, namely that the newest developments within the sciences have also resulted in a qualitative shift in the sciences themselves, problematizing this traditional image of the epistemologist. Serres radicalizes Bachelard’s claim that the sciences themselves produce philosophical categories, by claiming that they now also produce their own epistemology. Serres characterizes these new mature sciences as autoregulative or “autonormée[s].” Serres makes this claim first of all for mathematics:

At all moments of grand systematic reconstruction, the mathematicians become the epistemologists of their own knowledge. This transformation is a mutation that is carried out from the inside out. Everything happens as if, at the moment of promoting itself into a new system, mathematics suddenly needed to import the totality of epistemological questions.

In other passages he makes similar remarks about contemporary physics, for instance about the work of Léon Brillouin, *Science and information theory* (1956). “The philosophers do not have to search nor write a manual where one would find the epistemology of the experimental knowledge. It is there.” This has crucial consequences for the task of the philosopher. The idea is that, even if the traditional epistemological project succeeds and one is able to describe the scientific practice in a genuine way, one would only be repeating the sciences themselves. If so, in what sense, then, does the “philosopher’s work differ from that of a journalistic chronicler, who announces and comments on the news?” Or more precisely, the philosopher is confronted with a fundamental choice, which Serres at one moment compares to literary criticism. The literary critic either can choose to describe the text as loyally as possible, but he will end up in a philological exercise that will not really add anything significant; or else he tries to be more speculative, but he loses himself in an uncertain art of describing, linked to a certain normative framework. So either the epistemologist merely repeats the sciences or he becomes speculative, in that case implying a tension with the original idea of the primacy of science. Here already it is clear that it is precisely by pushing the traditional Bachelardian project to its boundaries that Serres arrives at one of his fundamental differences with Bachelard: if one would really take the surrationalism of Bachelard seriously, than one can no longer unproblematically write the
books Bachelard wrote.

3.3 From an epistemology to a political philosophy

However, Serres does not choose to give up all speculative ambition, but rather the opposite. One can never escape the speculative element, and it is therefore necessary to be explicit about it. For Serres, this means opening up for the political side of science as well. An encyclopedist would only add something to the internal epistemology of the sciences if he or she would speak of more than mere epistemology. “To speak the truth, my interest in the relations between science and society marked at the same time my difficulties with philosophy, and, most of all, with Canguilhem and Bachelard. They were out of their time. How could one teach epistemology of physics while omitting deontology?” Serres thus goes further than a mere epistemology in the traditional sense, switching to a political project, which aims to correct Bachelard’s project by articulating the political violence of the sciences as well. But even this break can be read as playing out Bachelard’s own cards against himself: if you really want to pursue an open philosophy, then you must also make room for the political and violent dimensions of science.

It is, however, incorrect if one would interpret this claim as saying that a political project is completely absent in the case of Bachelard, but present in that of Serres. To the contrary, in a famous essay “The Reformation and the Seven Sins” (see this issue) Serres argues that in Bachelard’s oeuvre there was always something like a political project. This project is exactly his presentism, the fact of looking for epistemological obstacles and epistemological breaks. For Serres, the model of purification is not only crippled epistemology but a crypto-normative project as well. It is a normative ideal where true science is seen as that which purifies itself from all the obstacles, from imagination, from myth. The *Formation of the scientific mind* (1938) of Bachelard is not (only) a description of scientific practice, but a political project of how the scientific city should be arranged, namely one with clear and strong walls against imagination, in favor of a spiritual purification of the scientist. Against this Serres states that “a totally purified reason is a myth” and that in fact “there is no purer myth than the idea of a science purified from all myth.” Exactly at this point, and once again, the model of proliferation will have to be introduced: it is through the creation of relations, not their destruction, that science comes about.
Does this mean that philosophers should give up normative ambitions completely according to Serres? Although it might seem so, this is not a necessary consequence. Indeed, refraining from giving a distorted reading of his epistemological project, Bachelard himself is not saying that one should use abstract philosophical distinctions to judge the history of science. Not at all, in fact he is claiming that the norms he uses originate in the scientific practices themselves, namely those imposed by the present sciences. Serres’s claim is not that one should stop using norms, but rather that one should be wary in what way one bases oneself on certain norms. The problem with Bachelard is not that he judges, but that by judging in his sense, he also endorses a certain political project embodied in the sciences, namely one that makes a distinction between a science that knows and a non-science that does not. It implies a reaffirmation of the political power of the sciences, of Modernity over non-modern elements (suspicions, non-western peoples, religion, etc.). One should—at least analytically—separate within surrationalism the epistemological project (the sur-) from the political one (the rationalism). One should be aware that one is doing both at the same time.

It is this double project Serres has in mind when he adds that the new scientific spirit of Bachelard not only ignored the scientific developments but also had not “heard the sound of Hiroshima.” Serres is puzzled by the paradox that something as rational as science can lead to something as irrational as the atomic bomb. In this context he makes some very strong claims, such as that “humanity is collectively suicidal” and that we live in a thanatocracy, a government of death. By these scientific developments, the whole world is in danger, because we are faced with what Serres calls world-objects, objects that span a whole dimension of the world (e.g. ballistic missiles span space; satellites span Earth’s rotation; nuclear waste spans time, etc.).

In the second place, the development of science is also reflected in a trend towards codification and secrecy, resulting in a science where “the foundation of scientific rationality is being destroyed.” Since scientific practices are auto-normative, they must be able to control themselves through critical inquiry. By locking up science in secrecy and national interests, one destroys this practice. Or as Serres states:

There is knowledge, but the open possibility of feedback control has decreased sharply, almost towards its final dissolution. However, from the moment there is no longer any control, counter-role, there is no longer any
rationality. The total of the network of scientific interferences does not have the possibility to control itself; although, that was its proper reason. \(^6\)

In Serres’s later work this critique gets further extended to other issues, mainly in two ways. First of all, Serres notices that the nuclear winter is not our only worry, or not even our greatest one. Since *Le contrat naturel* (1990) the problem of climate change, and in more recent work the one of the Anthropocene have come to the foreground. Much inspired by his ontology and epistemology, he understands these problems as a resistance of objects against our current networks, our current political collective. The social contract has to be replaced by a natural contract:

We so-called developed nations are no longer fighting among ourselves; together we are all turning against the world. Literally a world war, and doubly so, since the whole world, meaning all men, imposes losses on the world, meaning things. We shall thus seek to conclude a peace treaty. \(^7\)

This ecological problem is fundamentally linked with another of Serres’s concerns, namely the idea that our current way of doing and describing science is problematic, since it does not acknowledge the role objects play in science and society. The ecological crisis is just the clearest example of how by dividing science and culture, we are unable to account for the political consequences of science. In *Statues* Serres uses the example of the *Challenger* accident, the spaceship that exploded and killed all seven passengers. \(^8\) One could argue that this was a mere accident, but in fact, Serres claims it is no accident, but an essential element of science itself. We could have statistically predicted that such accidents would occur, similar to how we know that driving cars will imply traffic accidents. We accept these sacrifices, and find them necessary in order for our society to function, similar to how in mythical societies we have found it necessary to sacrifice persons for the gods, or select a scapegoat to restore social order. Choosing for our current way of doing science, means accepting these sacrifices. Worse even, we deem them necessary, otherwise our society would fall apart. To do epistemology, philosophy of science, one should also be concerned with this kind of violence in science and seek for a less lethal alternative. What Serres has in mind, then, is a political project: how to respect this open element of Bachelard, but at the same time conceptualize a new politics of science, free from the burden of a conception such as rationalism? Serres believes that this can be done by following the model of proliferation. In this sense, his epistemological model is a political model as
well, but a more explicit one.

CONCLUSION

This paper has tried to show how the work of Michel Serres must be seen not as an ‘epistemological break’ with Bachelard, but rather as a specific and critical continuation of certain of its methodological elements. Once again, the claim is not that there are no serious disagreements between both authors. They clearly have a different ontology and notions such as rationalism are differently evaluated. But at the same time Serres’s work can be read in line with some of Bachelardian notions such as philosophie du non and surrationalism. To do so, one has to look at Serres’s early work, where he tries to develop a new new scientific spirit, updating Bachelard’s new scientific spirit. But besides mere epistemological corrections, this also implied a shift in the role of the philosopher, who has to open him- or herself to political issues following from science. These shifts have been quite radical, so much so that Serres’s recent work is often quite distinct from what one should associate with Bachelard and the tradition of French historical epistemology. But the claim is that this shift itself was, at least partly, brought about (wittingly or unwittingly) by a certain loyalty to Bachelard’s surrationalism. It was precisely due to the insights Serres found in the new new scientific spirit, which opened up room for imagination and culture in science, that he saw the need for a political dimension of philosophy of science.

It is possible to argue that a similar move is also at work in the oeuvre of Latour and Stengers. They agree that it is the scientific field that should decide which distinctions are relevant and which are not, and philosophers “should be as undecided as the various actors we follow as to what technoscience is made of; to do so, every time an inside/outside division is built, we should follow the two sides simultaneously, making up a list, no matter how long and heterogeneous, of all those who do the work.”79 This is Latour’s famous dictum of ‘follow the actors,’ which can be interpreted acording to the lines of Bachelard’s surrationalism. A similar rule can be found in the work of Isabelle Stengers, who she aims at giving a description of the scientific practices that does not insult the scientists themselves.80 Both authors, however, follow Serres in stressing the importance of the political aspect, which remains underdeveloped in Bachelard’s work. To explore these aspects, however, a new paper would be required.81 Here, simply the possibility of this rereading of their work can be noted. Again, one should not be misled by their claims that they fully break with Bachelard. Rather—through their con-
nection via Serres—one can see their work as loyal to his legacy.
NOTES

5. The ontological and even political project at work in Serres's philosophy that he develops more extensively in later work has been discussed in a different article, see Massimiliano Simons, “The Parliament of Things and the Anthropocene: How to Listen to ‘Quasi-Objects,’” *Techné: Research in Philosophy and Technology* 21, no. 2-3 (2017): 150-174.
9. In fact, even logical positivism can be read in this manner, for instance by rereading the philosophy of science of authors like Rudolf Carnap through a Kantian lens. See Michael Friedman, *Reconsidering logical positivism*. Cambridge: Cambridge University press, 1999.
29. See Bachelard, *nouvel esprit*.
32. See Chimisso, *Bachelard*.
34. For instance, both Canguilhem and Foucault discuss the early work of Serres and vice versa Serres was quite aware of their work. See Georges Canguilhem, *Ideology and rationality in the history of the life sciences*. Cambridge, MA: MIT press, 1988, 18; Foucault, *The Archaeology of Knowledge and The Discourse on Language*. Pantheon Books: New York, 1972, 5, 190. Canguilhem was in fact one of his supervisors of his doctoral thesis, but Serres claims that the day of his defense was also the day both authors broke with one another. See Michel Serres, *Pantopie ou le monde de Michel Serres, de Hermès à Petite Poucette*. Paris : Le Pommier, 2016, 49. In the case of Foucault, Serres describes himself as “pupil and colleague.” See Serres and Latour, *Conversations*, 38.
47. Serres, *La communication*, 251n5.
50. This idea already echoes Serres’s later thought where he focuses on the role of ‘quasi-objects.’ See Simons, *Parliament of Things*. However, in the Hermes-series this remains embedded in structuralism, which will disappear from the end of the 1970s. From then on Serres is sceptical of the possibility of general metanarratives. In this later work he focuses more on the multiplic-
ity of relationships without clear boundaries, focusing on the role of myths and art. See Michel Serres, *Genèse*. Paris: Grasset, 1982 and Bruno Latour, “The Enlightenment without the Critique: A Word on Michel Serres’ Philosophy,” *Royal Institute of Philosophy Lecture Series* 21 (1987): 83-97. Like other poststructuralists, however, he remains fundamentally influenced by many of its themes. Since, however, his structuralism was not of the linguistic, but of the mathematical side (related to Bourbaki, among others), his position can best be described as a ‘mathematical poststructuralism.’


52. An open question is, even though there is no natural distinction between scientific and other practices, whether such a distinction cannot be a particular societal product. Some societies, perhaps our contemporary one, might be based on such a purifying construction that constructs a certain distinction between science and culture. Such an argument is, in fact, at work in the philosophy of Bruno Latour and Isabelle Stengers. See Latour, *Never Modern* and Isabelle Stengers, *The invention of modern science*. Minneapolis: University of Minnesota press, 2000.

53. See Stengers, *invention of modern science*.

54. Again, an open question here is whether science consists of certain theories, ideas, perspectives or rather certain practices, relations or material settings. The first option seems to be present in the work of Serres, the second in the work of Latour and Stengers. This might have something to do with the starting points of the authors, either in (bio)chemistry focusing on the material practices or in mathematics, starting from a more abstract approach.


59. This perspective is, for example, present in the work of Latour. His “explanatory model allows us instead to integrate the work of purification as a particular case of mediation [i.e. proliferation]. The only difference between the modern and nonmodern conception is therefore breached, since purification is considered as a useful work requiring instruments, institutions and know-how.” Latour, *Never Modern*, 78.

60. Serres, *La communication*, 70.


73. Serres, *La traduction*, 78.

75. Serres, La traduction, 88.
76. Serres, La traduction, 88. A similar worry is expressed by Stengers. In her case, the problem is how the knowledge economy is locking biomedical knowledge up behind pay walls and bio-industry, thus creating a scientist that is dependent on patents and not on this autonormativity. As a consequence “this quite specific social fabric will be destroyed when scientists as practitioners do not depend upon each other any longer, but are tied instead to competing industrial interests. It becomes then a matter of survival to confirm the kind of promises that attracted the appetites of investors, and to produce patentable results.” Isabelle Stengers, “Wondering About Materialism,” in The Speculative Turn: Continental Materialism and Realism. Eds Levi Bryant, Graham Harman and Nick Srnicek, Melbourne: re.press, 2011, 377.
INTRODUCTION

In recent years scholars from different fields have taken up the notion of rhythm to analyse different temporal and spatial phenomena. Despite this turn towards rhythm, however, the term has remained enigmatic. We experience rhythm in everything, but we don’t seem to be able to generate a clear understanding of how rhythm operates. As Jacques Derrida mentioned “rhythm has always haunted our tradition, without ever reaching the centre of its concerns.” In his article I aim to explore the operational capacity of rhythm, by analysing the work of two philosophers who devoted a great deal of attention to the concept: Gaston Bachelard and Henri Bergson. Both agree that rhythm plays a crucial role in the constitution of singular temporal existence: for Bergson it emerges when the omnipresent force of duration expresses itself in and through a distinct phenomenon, for Bachelard, by contrast, rhythm should be considered as the temporal architecture that is constitutive for the durational existence of singular entities. Exploring both theories of rhythm will allow me to come to a better understanding of how rhythm operates and how it relates to our experience of time.

For most of the English-speaking world the concept of rhythm and the method of rhythmanalysis is inherently connected to the theoretical oeuvre of French phi-
losopher and social theorist Henri Lefebvre. The translation of his book *Rhythmanalysis: Space, Time and Everyday Life* in 2012 seems to herald rhythm’s appearance on the theoretical stage. The rhythmanalytical project, however, does not begin with Lefebvre’s book, but can be traced back to the work of Gaston Bachelard and, more specific, to his book *La dialectique de la durée* (1936). In the last chapter of this book, which bears the title ‘Rhythmanalysis,’ Bachelard argues that one should never lose sight of the fact that “all exchanges take place through rhythms.” Building on the work of Portuguese philosopher Lúcio Alberto Pinheiro dos Santos, from whom Bachelard borrows the term rhythmanalysis, the philosopher here advocates for an active rhythmanalytical theory that never loses sight of the fact that rhythm constitutes “the basis of the dynamics of both life and the psyche” (DD 128).

Bachelard’s conceptualization of rhythm fits in with a broader philosophy of time that the French philosopher was developing during his teaching period in Dijon between 1930 and 1940. This philosophical work resulted in two books, *L’intuition de l’instant* (1932) and *La dialectic de la durée* (1936), and two articles, “Instant Poétique et instant Métaphisique” (1931) and “La continuité et la multiplicité temporelles” (1937). Bachelard framed this entire philosophy of time as a critique against Bergsonism and the Bergsonians, which he explicitly characterises as his “adversaries” (DD 11). Although Bachelard is sympathetic to Bergson’s attempt to develop a theory of time that does not understand temporality as abstract clock time, he profoundly disagrees with the Bergsonian idea of duration. For Bachelard time should not be understood as a continuous flow, in which the past is prolonged into the present, but as fractured and constantly riven, the present constantly breaking away from its past. The conceptualization of rhythm fits in this argument against Bergsonian duration. By advancing rhythm as a “fundamental temporal notion” (DD ix), Bachelard aims to replace Bergson’s conceptualization of time as duration with a reading of time in which continuity is the result of a rhythmic interplay.

In recent years Bachelard’s philosophy of time and the accompanying polemic with Bergson have received new attention in different books and edited volumes. In spite of Bachelard’s explicit critique, these works refuse to frame the discussion between Bergson and Bachelard in terms of a simple opposition. The idea behind this is that in his attempt to pick a fight with his contemporary, Bachelard not only failed to give an accurate account of the subtlety and complexity of the Bergsonian project, but also caricaturised his own philosophy.

Indeed, a close
reading of both theoretical oeuvres shows more points of convergence than Bachelard seems willing to acknowledge. While I agree that it is important to look for the different affinities underlying the apparent difference between both philosophers, I would however also like to stress the fundamental difference between both philosophers. Although Bachelard takes up and re-reads a lot of concepts that were developed by Bergson, in the end his vision on time is radically different from that of Bergson. As Jean François Perraudin argues, this difference appears most clearly when we look at the “practical and therapeutic perspectives” of the theory, which indicates fundamentally different perspectives on how to relate to time. By exploring how both philosophers develop the concept of rhythm in and through their oeuvre, I want to show the many micro-relations that emerge in between Bergson’s and Bachelard’s analysis of time, while drawing attention to the profound differences in their attitude towards it.

BERGSON AND BACHELARD: CONTINUITY, DISCONTINUITY AND RHYTHM

A reader of Bachelard does not even need to reach the first chapters of L’intuition de L’instant and La dialectique de la durée to realize the polemic character of both books. The titles already indicate Bachelard’s aim to radically rethink key concepts of the Bergsonian philosophy. In L’intuition de l’instant Bachelard connects intuition, described by Bergson as the “direct vision” via which we “experience the uninterrupted prolongation of the past in the present encroaching towards the future,” to the discontinuous instant. In doing so he not only brings together two concepts that are opposed in Bergson’s philosophical system, but also blurs the Bergsonian distinction between the intellect, which deals with the instantaneous, and philosophical/artistic intuition, which deals with duration. In a similar fashion La dialectique de la durée provokes the Bergsonian system, as it transforms duration, which Bergson describes as an immediate given of consciousness, into a dialectical movement. Duration is here no longer the ontological primary source of life, but rather the product of a discontinuous alternation of something and nothing.

Bachelard’s critique of the Bergsonian project is primarily directed against Bergson’s concept of continuity. Bachelard wishes to develop a “discontinuous Bergsonism” (DD 8), ironically stating that “of Bergsonism we accept everything but continuity” (DD 7). However, in spite of Bachelard’s attempts to break the Bergsonian continuity, the discussion between the two philosophers cannot be reduced to a rigid polemic between homogenous continuity, illustrated by Bergson,
and absolute discontinuity, illustrated by Bachelard, for two main reasons. Firstly, Bachelard’s theory cannot simply be reduced to a plea for discontinuity, rather one of Bachelard’s main goals in both *L’intuition de l’instant* and *La dialectique de la durée* is to understand how duration works. While in the beginning of *L’intuition de l’instant*, he firmly states that “time presents itself as solitary instant,” he later on wonders how this solitary instant can be related to “the becoming of being” (II 60), thus trying to understand the “continuity of the discontinuous” (II 68). Secondly, Bachelard’s characterisation—or caricaturisation—of Bergson’s duration as homogeneous continuity, fails to appreciate the fact that Bergson himself continuously critiques the idea of one all-encompassing duration. Already in his first major book Bergson describes duration in terms of “qualitative multiplicity” and “absolute heterogeneity,” stating that a conceptualization of duration as something homogenous would make freedom incomprehensible. In the books that follow Bergson consistently talks about “durations with different elasticity,” or about a “continuity of durations.”

Rather than understanding the distinction between continuity and discontinuity as the end point of the discussion, and choosing one or the other, this distinction can serve as the point of departure for a discussion. For both Bachelard and Bergson concrete duration can only be understood as the outcome of a relation between continuity and discontinuity, or between a “dynamic force” and a “force of resistance.” To understand this relation, both Bergson and Bachelard seek recourse to the mechanisms of rhythm. Connected to both flow and form, to free-flowing movement and the organization of movement according to a beat, rhythm is an apt tool to understand the interaction between the forces of continuity and those of discontinuity. Consequently, both philosophers use it to conceptualize the concrete temporal existence and to analyze the difference between singular temporalities. Advocating neither absolute discontinuity nor homogeneous continuity, both philosophers try to understand the different temporalities that we experience as a complex rhythmic interplay between break and flow. According to Bergson, there is “no unique rhythm of duration,” but a multiplicity of “different rhythms,” which are each marked by a specific degree of tension, or relaxation that “fixes their respective places in the series of being” (MM 232). For Bachelard, on the other hand, it is “impossible not to recognize the need to base complex life on “a plurality of durations that have neither the same rhythm nor the same solidity in their sequence, nor the same power of continuity” (DD viii).
These similarities, however, cannot lead to a simple equation of both theories, or to an understanding of Bachelard’s project as a mere rearticulation of Bergson. Both philosophers coin rhythm as a key concept, but they conceptualize rhythm radically different. To understand this, I will have to take a closer look at the conceptualization of rhythm in the work of Bergson and Bachelard.

RHYTHM IN BERGSON: MELODIES AND VIBRATIONS

Although Bachelard suggests otherwise, Bergson devotes a lot of attention to the idea of rhythm. It is a key concept in *Matière et mémoire* (1896) and already plays an important role in his first major work *Essai sur les données immédiates de la conscience* (1889). As is well known, the basic claim of *Essai* is that our inner experience of time is corrupted by space. Both common sense, science and philosophy have the tendency to reduce our inner experience of temporality to a sequence of now-moments, thus reducing time to a “homogeneous medium in which our conscious states are ranged alongside one another as in space, so as to form discrete multiplicity” (E 67). However, “when our ego lets itself live, when it refrains from separating, its present states form its former states” (E 75). This leads to a completely different experience of time, not as the repetition of instants, but as duration. That is, as “nothing but a succession of qualitative changes, which melt into and permeate one another, without precise outlines, without any tendency to externalise themselves in relation to one another, without any affiliation with number” (E 77). To illustrate this experience of duration Bergson refers to the metaphor of melody, where the different notes interpenetrate each other to form one heterogeneous unity, an organic and dynamic whole “comparable to a living being” (E 75). Similar to duration, we cannot understand a melody by breaking it down into discrete unit or notes. In order to understand it we should immerse ourselves into the movement of the music and let ourselves get carried away by its flow.

With the development of melody as one of the dominant metaphors for duration, rhythm also appears in Bergson’s discourse. Bergson sees a close relation between rhythm and melody, as both phenomena relate to a durational understanding of time. Take for example Bergson’s famous passage of the sounds of the bell:

The sounds of the bell certainly reach me one after the other; but one of two alternatives must be true. Either I retain each of these successive sensations in order to combine it with the others and form a group which re-
minds me of an air or rhythm which I know: in that case I do not count the sounds, I limit myself to gathering, so to speak, the qualitative impression produced by the whole series. Or else I intend explicitly to count them, and then I shall have to separate them, and this separation must take place within some homogeneous medium in which the sounds, stripped of their qualities, and in a manner emptied, leave traces of their presence, which are absolutely alike. (E 64-65; my emphasis)

In this passage, Bergson explicitly links rhythm to melody and, consequently, to duration. When we “limit” ourselves to the qualitative impression produced by the whole series, we experience it as rhythmic. Despite this link, however, rhythm should not simply be equated with melody, or with duration. As we will see, rhythm merely suggests or points to melodic duration, but does not coincide with it.

Unlike many of his contemporaries, Bergson does not make a distinction between rhythm and measure. In the first half of twentieth century, it was common to distinguish artificial measure or meter, which was found in the stomping repetitions of the new mechanic labour, from natural rhythms, connected to the organic pulsation of the heart or the waves of the sea. In Essai, however, Bergson defines rhythm as an aesthetic tool, refusing to connect it to nature: “Nature, like art, proceeds by suggestion, but does not command the resources of rhythm” (E 12).

Moreover, contrary to what we might expect from a philosopher with a clear predilection for gracious organic movement, Bergson states that the aesthetic power of rhythm resides exactly in its repetitive and predictable character. The “regularity of the rhythm” takes “complete possession of our thought and will” and gives us the feeling that we participate in the movement of the work of art (E 9-10).

Referring to poetry, Bergson describes this quality as follows:

The poet is he with whom feelings develop into images, and the images themselves into words, which translate them while obeying the laws of rhythm. In seeing these images pass before our eyes we in our turn experience the feeling which was, so to speak their emotional equivalent: but we should never realize these images so strongly without the regular movement of the rhythm by which our soul is lulled into self-forgetfulness, and, as in a dream thinks and sees with the poet. (E 11; my emphasis)

Through its regular movement rhythm makes us forget ourselves. In turn, this forgetting of the self allows us to immerse ourselves into the movement that is
suggested by the phrase and to get carried away by its momentum. This can be connected to the previous example of the bell. It is no coincidence that Bergson uses an example that is markedly amelodic. The monotone and staccato repetition of the strokes serves as the condition for a state of self-forgetfulness, which in turn allows for the experience of real duration. Rhythm thus functions as “instrument of suggestion,” or “vector of hypnosis.” Its repetition, which in itself is quantitative, makes the listener forget her/himself and lulls her in a state where she experiences the different strokes as one continuous melody. Rhythm, argues Bergson, functions as tool to evoke duration, it is “the quality of quantity” (E 92).

In *Matière et mémoire* Bergson at the same time takes up this conceptualization of rhythm and changes it drastically. As in *Essai*, rhythm takes up an ambiguous position, being that in extensive reality that points to intensive duration. Contrary to *Essai*, however, this ‘pointing to’ should no longer be understood in terms of suggestion, but in terms of expression. In *Matière et mémoire* rhythm is no longer reduced to an aesthetic tool. Rather, it becomes an ontological operation through which duration expresses itself in concrete entities. Bergson here trades the rigid bifurcation, where inextensive time and extensive space are radically separated categories, for a view in which time and space are extremes on a continuum, or opposite forces that are always co-present. As such, every real phenomenon is “something intermediate between divided *extension* [pure space] and pure *inextension* [or duration]” (MM 276). In this context, rhythm gets a new function. It no longer suggests pure duration, but expresses concrete duration. Rhythm is here conceived as the specific outcome of the concrete interplay between the forces of *extension* and *inextension* that takes place in each phenomenon and characterizes it.

In *Matière et mémoire*, rhythm is the defining feature of the phenomena: not only does everything have its own rhythm, *rather, each entity is its rhythm*. To understand this, we need to take into account Bergson’s understanding of durational movement as vibrational. As we have seen, duration is no longer a specific quality of our inner experience of time, but a force that permeates everything and makes everything move or “vibrate.” What appears stable and solid on the macro-level, “resolves itself into numberless vibration” on the micro-level (MM 234). In other words, everything consists of vibration. What makes something singular is simply its rate of vibration, or rhythm. Elements that testify to a more powerful presence of the force of *inextension*, like the mind, have a higher more fluid rhythm. Elements in which the *extensive* forces are more present, like material...
objects, have a slower, more solid, rhythm. By introducing these differences in rhythm, or rate of vibration, Bergson not only explains the difference between elements, but he also reveals the reason why we experience stability. According to Bergson, the rhythm of our consciousness is so high that it fails to experience the slow rhythm of material things. To illustrate this Bergson refers to the perception of colours.

May we not conceive, for instance, that the irreducibility of two perceived colours is due mainly to the narrow duration into which are contracted the billions of vibrations, which they execute in one of our moments? If we could stretch out this duration, that is to say, live at a slower rhythm, should we not, as the rhythm slowed down, see these colours pale and lengthen into successive impressions, still coloured, no doubt, but nearer and nearer to coincidence with pure vibrations? In cases where the rhythm of the movement is slow enough to tally with the habits of our consciousness - as in the case of the deep notes of the musical scale, for instance - do we not feel that the quality perceived analyses itself into repeated and successive vibrations, bound together by an inner continuity? (MM 127-128; my emphasis)

The fact that we perceive a colour as a stable quality can be explained by the difference in rhythm between vibrations of the colour and of our consciousness. Take for example the perception of red light. According to Bergson, our psychological perception of one second of red light corresponds with 400 billion physical vibrations of waves. Through our perception we habitually contract these vibrations of the “infinitely diluted existence” of the colour into a few moments of our “more intense life,” thus perceiving these waves as one stable quality.

Bergson thus paints a picture of a world where everything vibrates and where the difference between phenomena is reduced to differences in rhythm. The only reason why we experience stability is because we impose our intense rhythm of duration onto the slower rhythms, thus condensing a dynamic sequence of vibrations into one stable image. In short, “to perceive means to immobilize” (MM 233). In itself, Bergson does not perceive this stabilizing process as problematic. Quite the contrary, in order to analyse our environment and to act upon it we need to create stability, which means that we have to impose our rhythm on the things that surrounds us. However, although this imposition is important for utilitarian ends, we simply need to immobilize the phenomena that surround us in order to
survive, it is also a reduction of reality. By forcing the rich polyrhythmic reality to follow one dominant rhythm, we “turn our back upon true knowledge” (MM 222). If we really want to comprehend life, we need to reverse this movement. Rather than imposing our rhythm on the external reality we need to dissolve, or dilate, our rhythm and enter into the rhythms of the durational reality that surrounds us. Bergson defines this method as intuition. In opposition to intelligence, which follows the above-described procedure, intuition allows us to relax our own rhythm and to experience the other rhythms of durance. Here we are “thinking backwards,” so that we can “expand our scope of perception.” According to Bergson this method is native to the artist and the philosopher. Contrary to the scientist who imposes his rhythm on the material, the philosopher/artist tries to penetrate into the inner rhythms of the material that she is dealing with. As such, she is able to express life in all its durational, or vibrational complexity. In Evolution Créatrice (1941) Bergson elaborates this idea, as he describes the higher effort of intuition as a way to coincide with matter “adopting the same rhythm and the same movement.” This effort helps the philosopher/artist to go against “the natural inclination of intelligence,” and to grasp reality from within. Or, as Le Roy states in Une philosophie nouvelle—Henri Bergson (1912) the “absolute revelation is only given to the man who passes into the object, flings himself upon the stream, and lives within its rhythm.”

BACHELARD AND RHYTHM: HABITS AND DIALECTICS

Already in the first sentence of L’intuition de l’instant Bachelard clarifies the stakes of his book, as he argues that: Time has but one reality, the reality of the instant (II 13). Throughout the book Bachelard comes back to the idea that time can only exist as solitary instant, thus depriving past and future from any ontological reality. This ontological preference for the instant, however, confronts Bachelard with the challenge to understand why we experience time as something that is continuously unfolding. How can we have the impression of duration, when time should, both ontologically and intuitively, be understood as “a reality grafted on the instant and suspended between two nothingnesses” (II 13). Bachelard’s answer to this question is rhythm. According to Bachelard, the feeling of continuity between past, present and future is created by rhythms, which transform independent moments into “groupings of instants” or patterns (II 90). This continuity, however, is not grounded in reality. Past and future are merely dimensions of the present, which is the only reality of time. The past is thus reduced to the retention or echo of what was, and the future to the anticipation of, or intent to-
Towards what is about to come. Or, as Bachelard states, “the past is as empty as the future” and “the future is as dead as the past” (II 48).

Durational continuity is thus not a “direct force,” but the product of rhythms that establish themselves—and always have to re-establish themselves—in the present. Bachelard stresses that these rhythms are not predicated on a “pre-established harmony,” but that they are habitual: “past and future are essentially no more than habits” (II 51). The philosopher’s conceptualization of habit, however, differs from our common sense understanding of the term. Traditionally we understand habits as patterns that we establish throughout repetition. We have the habit to say ‘sorry’ when we bump into somebody in the streets, or to stop when the traffic light turns red. Habits are here understood as actions that we do. For Bachelard, however, habits are “fundamental” (II 70). We don’t perform them, but they constitute us. Habitual rhythms construct durational continuity, thus creating a sense of self or an identity. Or, more prosaically phrased:

Global identity is thus composed of more or less accurate repetitions, more or less detailed reflections. The individual will no doubt make an effort to trace its today upon its yesterday, and this copy will be aided by the dynamic of rhythms. [...] Life carries our image from mirror to mirror. (II 71; my emphasis)

Our individual existence and identity are nothing but a habitual rhythm that needs to be re-actualized in every moment: “We should neither speak of the unity of the self nor of the identity of the self beyond synthesis of the instant” (II 71). The individual self, in so far as it persists through time, is nothing but “the integral sum of rhythms.”

In other words, we don’t constitute habitual rhythms, but habitual rhythms constitute us. In condensing different instants into a continuous temporal pattern, they also tie together the individual identity and make that identity persist in and through time. This persistence, moreover, should not be understood as a simple repetition, but as a progression. This leads to a second fundamental difference between our common sense understanding of rhythm and Bachelard’s conceptualization of the term. According to Bachelard habit should not be understood in terms of a status quo, something that does not develop through time, but as something that constantly renews itself and changes. Bachelard gives the example of playing the piano. If we want to develop our piano playing, we have to practice
every day, incorporating new elements in our technique. A habitual rhythm is thus always a “synthesis of novelty and routine” (II 65). In order to be efficient, a habit has to learn. It has to deal with novelty or difference, and to adapt its rhythm in order to incorporate this new element. If it isn’t able to do this, the rhythm will no longer be useful and, consequently, no longer be reiterated in the instant. In other words, “what persist is always what regenerates itself” (II 83). The past only stays when it is re-actualised in the present and it is only re-articulated in the present when it serves the progression of this present. Paraphrasing Nietzsche, Bachelard here talks about an “eternal reprise,” rather than an “eternal return” (II 81-82).

In *La dialectique de la durée* Bachelard returns to the idea that durational continuity is “constructed with rhythms” rather than being based on pre-established “temporal base” (DD ix). He picks up Bergson’s metaphor of the melody to underscore this idea. According to Bachelard “[w]e must in fact learn the continuity of a melody” (DD 114). Melodic continuity is thus never experienced instantly. Instead, it is “the recognition of a theme that makes us aware of the melodic continuity.” We have to learn the continuity of a melody. We have to repeat and memorise its theme, before we can experience it as a durational continuity. In line with what we said before, this learning, however, cannot simply be equated with active learning, rather it resembles the way in which our perception is always conditioned by the patterns that we—consciously or unconsciously—*inhabit*. We don’t have to study each individual tune in order to like it, but for us to acknowledge it as a melody, it has to be part of our habit. In other words, if we would have been born in a different time or place, we would not recognize its melodic continuity. In other words, melodic durations are always established belatedly (*après coup*) when we have trained the ear to recognize certain patterns.

In *La dialectique de la durée* Bachelard not only takes up his earlier conceptualization of rhythm, he also develops it. In this book Bachelard relates rhythm to the idea of dialectics. Rhythm is no longer simply sequential, connecting different moments into a continuous refrain, but develops itself dialectically. This dialectics operate in a double fashion. Firstly, dialectics refers to a “fundamental heterogeneity that lies at the very heart of lived, active, creative duration” (DD 8). According to Bachelard, duration is constituted by the dual operation of two states: creation and destruction, work and repose, affirmation and negation. This duality is crucial if we want to understand the possibility of change or the introduction of newness in time. For something to appear as new it should always break away from what came before. As such, every change is preceded by a moment of nega-
tion. Rather than being a concatenation of instants, rhythm thus appears as the alternation of—or interaction between—two opposite possibilities: “either in this instant nothing is happening, or else in the instant, something is happening.” Secondly, dialectics also refers to the fact that every rhythm is dialectically conditioned by other rhythms. Rhythms are always “relative.” They interrupt, build on, take their cues from or syncopate one another. Rhythms are thus always “overlaid and interdependendant” (DD 123). They constantly interlock and superimpose so as to create a larger harmony of time.

This multiplicity, or density, also explains why we experience time as continuous and things as stable through time. Continuity cannot be found on the level of the individual rhythms, which are always the result of a dialectics between something and nothing, but is experienced at the higher level, where the different discontinuous rhythms are superimposed, and the different states have neutralized each other. Bachelard here refers to another musical metaphor: the orchestra. According to Bachelard the durational continuity of the music is not experienced at the level of the individual musicians, as these musicians are not continuously playing. Rather, it is experienced at the level of the orchestra, where the different instruments, which each play their own discontinuous line, come together to perform an overall harmony. In sum, the overall continuity of time is not connected to “one fundamental rhythm to which all the instruments refer,” but rather to the summation of the different rhythms of the different instruments that “support each other and carry each other along” (DD 123). There is not one fundamental rhythm to which the instruments obey, but rather different independent rhythms that have to be brought together to form a continuous harmony. Time should thus not be understood as a single thread, but as a tapestry, in which different threads are woven together to form a rich temporal texture.

CONCLUSION: BACHELARD AND THE CREATION OF NEW RHYTHMIC TEXTURES

Despite the fact that Bachelard throws down the gauntlet to Bergson, there are still clear resemblances between the conceptualization of rhythm in both philosophical systems. Both Bachelard and Bergson coin rhythm as a crucial instrument to understand concrete duration. Rhythm is the pacemaker of our temporal existence. As such, rhythm is not only constitutive for the self, as it creates the temporality in which this self can live and persist through time, but also it is the tool via which we impose our time on the world that surround us and make it our
home. In Bergson’s case this happens because through our perception, we impose the fast rhythm of our thinking onto the slow rhythm of material things, thus immobilizing them and making it possible for us to use them. In the case of Bachelard it is through our habits that we create a sustainable habitus for ourselves and find our place in the symphony of life.

Nevertheless, both philosophers have a fundamentally different vision on how we should relate to these rhythms. For Bergson, rhythm is an expression of the durational force that permeates everything and gives everything a specific (im)pulse. Consequently, rhythm is not only a tool via which we impose our will on our surrounding world, but also a way to connect to gain ‘true knowledge’ about that world, experiencing it “from within” (MM 72). When we disengage ourselves from the particular rhythm of our consciousness and tune into the rhythms of duration we will manage to come into contact with the primary forces of life that are lurking underneath the superficial temporality of everyday life. For Bachelard, on the other hand, rhythms should not be understood as the expression of duration, but as that what produces duration. As such, the rhythms of becoming do not express anything natural or immediate. Quite the contrary, rhythms are always constructed. They are habits that, although primary to and constitutive for the individual self, fail to express any deeper truth about that self or the reality it relates to. For this reason, Bachelard is not interested in the search for the originary or primal rhythms of duration, but in the creation of radically new rhythmic constellations. Bachelard is fascinated by the moments of abrupt irruptions, when old rhythms are negated and new temporal structures are created: “Flat horizontality suddenly vanishes. Time no longer flows. It spouts [jaillit].” (II 106)

Bachelard finds this attempt to construct new rhythmic constellations in two figures that he holds in the highest esteem: the scientist and the poet. The scientist is the one who says no to tradition, as he abandons the values and interests that guide our practical life. She “must first destroy in order to make room for her constructions” (DD 14). As Bachelard states in *Rationalisme Applique* (1966), her method—the “antithesis of the habit”—imposes a “chronotechnique” that “expels lived duration,” thus producing a “suspended time” in which new “significant events” or new rhythmic constellations can emerge. Similarly, the poet has the task to shatter the “simple continuity of shackled time” in order to make new temporalities arise (II 58). “Being a poet means multiplying the temporal dialectic and refusing the easy continuity of sensation and deduction” (DD 124). Contrary to Bergson, for whom poetry should create a regular meter that lulls the listen-
er/reader into a state self-forgetfulness, Bachelard’s argues that “the rhythmics of poetry gradually breaks away from ideas of measurement and is arithmetised by grouping together notable instants rather than by measuring uniform durations” (Bergson 1950, 124). Here the reader/listener does not regain contact with the original rhythms of durance, but is confronted with the possibilities of new rhythms, new temporalities that emerge out of the poetic experimentation. As Bachelard mentions in Poetics of Space, the poem here gives us a “veritable cure of rhythmanalysis”: “to charm or to disturb—always to awaken—the sleeping being lost in its automatisms.”

Contrary to Bergson, Bachelard is not interested in the actual time in which we live, but in the possible times that we can think of, or imagine. Rhythms should not be traced back to their temporal origins. Rather, they should be broken up and deconstructed so that new significant rhythms can emerge. Or, as Bachelard argues in the article Surrationalism, which was published in the same year as Dialectique de la durée, we should advocate a new model of thinking: “To turn the rationalism from the past towards the future, from recollection towards the tentative, from the elementary towards the complex, from the logic towards the surlogic these are the indispensible tasks of a spiritual revolution.” It is within this context that we can best understand Bachelard’s rhythmanalytical project: not so much as an analytical method, than as a pedagogical project. Understanding how life operates rhythmically will allow us to “regain mastery of the dialectics of duration” and to create new temporal structures (DD 154). Consequently, the ongoing task of rhythmanalysis is to “look anywhere and everywhere in order to discover new opportunities for creating rhythms” (DD 148).
NOTES


4. Lefebvre explicitly acknowledges his indebtedness to Bachelard when he traced the emergence of the rhythmanalytical project. Remarkably, he refers to *Psychoanalysis of fire* (1938) rather than to *Dialectique de la Durée*, published two years earlier, in which the idea of rhythmanalysis is developed in a more profound and extensive way (see: Henri Lefebvre, Éléments de rythmanalyse. Paris: Éditions Syllepse, 1992, 9).

5. Gaston Bachelard, *La Dialectique de la durée*. Paris: Presses Universitaire de France, 1950, 157. We will continue to refer to this book within the text as DD.

6. The Portuguese professor in literature and psychology Lúcio Alberto Pinheiro dos Santos allegedly coined the term rhythmanalysis in 1931, when he wrote *La Rythmanalyse*. However, up until today the theoretical relevance of this work remains unclear, as the book was never published and the original manuscript is lost. The only in-depth reference to the text can be found in Gaston Bachelard *Dialectics of Duration*. Moreover, as Bachelard neither intends “to give an over-all view of these nor to describe all the many lines of development,” it is virtually impossible to make claims about dos Santos’s own theory.

7. Bachelard’s work on temporality took up a special position in his thinking. As is well known, Bachelard advocates a separation between scientific rationality (the diurnal, the animus) and poetic reverie (the nocturnal, the anima). This plea resulted in an oeuvre that is divided between works on epistemology and science, on the one hand, and works on aesthetics and poetical imagination, on the other hand. His writings on time, however, do not adhere to this strict division. They are neither epistemological, nor aesthetical, but venture into ontological domains. Drawing on both scientific findings (relativity theory, set theory, quantum physics) and aesthetic sources (literature, poetry, musical theory) Bachelard here tries to grasp the reality of time. As Gaspare Polizzi argues, however, this “absence of a dichotomy between rationality and reverie” should not be understood as a limitation, but as a “node of potential problems for the future expression of Bachelard’s thinking” (See: Gaspare Polizzi, “Rythme et Durée: la philosophie du temps chez Bergson et Bachelard.” In *Bachelard & Bergson: Continuité et discontinuité*, by Frédéric Worms and Jean-Jacques Wunenburger, 53-72. Paris: Presses Universitaire de France, p. 71)

8. Bachelard has a habit of developing his philosophy in and through a polemical debate with other philosopher. In *Formation of the Scientific Mind* (1967) he even advocates to replace Kant’s “architectonic reason” with a “polemical reason” (10). A few years earlier Bachelard fostered a comparable polemic with philosopher and chemist Émile Meyerson in *La valeur inductive de la relativité* (1929). Using a similar rhetorical strategy as in his books on Bergson, Bachelard’s here inverts the title of Meyerson’s book *La Déduction relativiste*, which was published 1925 (cf. infra).

10. This misrepresentation of the Bergsonian framework should not be understood as negligence, but as a rhetorical tool that Bachelard uses to make his own theory more clear. Several passages suggest that Bachelard has read Bergson carefully. As Gouhier mentions, rather than a lack of understanding, “Bachelard needs to alter Bergson in order to be Bachelard” (Herni Gouhier, “Discussion.” In *Bachelard: Colloque de Cerisy* (1970). Paris: Hermann Éditeurs, 1974, 359).


14. However, these titles also how Bachelard was not simply rejecting the Bergsonian project but rather rethinks it. As Frédéric Worms points out, *Dialectique de la Durée* and *L'intuition de L'instant* establish a relation with the Bergsonian project based on a chiasm rather then on a simple opposition. This entails that Bachelard preserves the “principle stakes”: “there is still intuition, there is still duration, one does not get rid of the categories, nor of the questions” (Frédéric Worms, “La rupture de Bachelard avec Bergson comme point d'unité de la philosophie du xxe siècle en France.” In *Bachelard et Bergson: Continuité et discontinuité?*, by Frédéric Worms and Jean-Jacques Wunenburger. Paris: Cairn, 2008, 40).

15. Bachelard Gaston, *L'intuition de L'instant*. Paris: Livre de Poche, 1932, 13. We will continue to refer to this book within the text as II.

16. Similarly, *La dialectique de la durée* argues for the need to understand “being” in terms of “becoming” (DD 16).

17. Henri Bergson, *Essai sur les données immédiates de la conscience*. Paris: Les Presses universitaires de France, 1927, 127. We will continue to refer to this book within the text as E.


21. This conceptualization of rhythm as central concept does not come out of thin air. Quite the contrary, around the turn of the twentieth century rhythm was “one of European’s most fetishized keywords” (Lubkoll, Christine. “Rhythmus: Zum Komplex von Lebensphilosophie und ästhetischerModerne.” In *Das Imaginäre des Fin de siècle: Ein Symposium for Gerhard Neumann*, by Christine Lubkoll (ed.), Freiburg: Rombach, 2002). It occupied a central position in the in the theoretical writings of philosophers, natural scientists, psychologist and social theorist and was often framed as a mechanism that underscores all movement (see also: Golston, Micheal. “‘im anfang war der rhythmus’: rhythmic incubation in discourses of mind body and race from 1850-1944.” *Standfort Humanities Review*, 5, 1996).

23. In *Le Rire* (1910) we can find a similar passage, when Bergson states that the power of rhythm and assonance in poetry is to “rocks [bercer] our imagination, taking it back from the same to the same in a regular swing, and thus gently preparing it to receive the suggested vision (Henri Bergson, *Le Rire: Essai sur la signification du comique.* Paris: Felix Alcan, 1910, 62-63).

24. Christophe Corbier shows how most of the images that Bergson uses to illustrate the intuition of duration are distinctly amelodic: the strokes of the bell, the oscillation of a pendulum, the blows of the hammer (Christophe Corbier, “Bachelard, Bergson, Emmanuel: Mélodie, rythme et durée.” *Archives de Philosophie* 75, no. 2 [2012]: 296).


30. Bachelard ascribes this statement to Gaston Roupnel. Throughout the whole book Bachelard will come back to the “Roupnelian theory.” We can see that Bachelard here adopts a similar rhetorical strategy as in the last chapter of *Dialectique de la durée*. Again Bachelard claims to explain and defend the theory of somebody who, although this time it is a published author, most of his readers will not know, thus creating an interesting confusion between first- and second-hand knowledge.

31. Bachelard was neither the only nor the first philosopher to give the concept of habit an important place in his thinking and to see it as a creative act. Quite the contrary, by conceiving habit as something that is crucial for both the internal organisation of the living being and its relation with the environment Bachelard seems to inscribe himself into a discourse that emerged in nineteenth- and early twentieth-century that was advanced by philosophers like Albert Lemoine, Félix Ravaissant and—as we have seen—Bergson. Contrary to early modernist philosopher like Emmanuel Kant and Rene Descartes, who understood habit as an obstacle for freedom because it reduces human action to the order of the mechanical, these philosophers tried to give a more positive account of habit, understanding it as a creative act that is able to establish stability in an ever changing world (Elisabeth Grosz, “Habit Today: Ravaissant, Bergson, Deleuze and Us.” *Body & Society* 2/3 [2013]: 217-239; Mark Sinclair, “Habit and time in the nineteenth-century French philosophy: Albert Lemoine between Bergson adn Ravaissant.” *British Journal for the History of Philosophy* 1, no. 26 [2018]: 131-153). Gilles Deleuze is one of the more recent authors to have build on this line of thinking. In *Difference and Repetition* he connects habit to the passive synthesis of the present, arguing that habit is constitutive for our experience of the living present (Gilles Deleuze, *Différence et répétition.* Paris: Presses Universitaite de France, 1968).

32. Bachelard continues to connect the idea of constant renewal with the idea of progression. Habits are not only dynamic, constantly changing as they synthesize the memory of the old and the emergence of the new, but they are also progressive. Throughout its repetition, rhythms are gradually becoming more rational, more righteous and more beautiful. (II 94-95). Although, the rhythmic patterns that emerge are in themselves completely accidental, only the patterns that propel us into a better future will be preserved. All the other habitual patterns will eventually disappear. In other words, progression is not driven by a force that pushes it in a certain direction, but by a project that pulls us: “What compels us to preserve in being is then not so much a set of forces as it is a set of reasons” (MM 74).
33. Although Bachelard refers only a few times to science in *Dialectic*, we can see a close relation between Bachelard’s philosophy of time and his philosophy of science when he talks about the dialectics of time. For Bachelard the dialectical method is inherently to the scientific approach to knowledge production, where new scientific experiments always aims to negate, or falsify existing theories in order to come to new knowledge (see: Gaston Bachelard, *La Philosphie du non: Essai d’une philosphy du nouvel esprit scientific*. Paris: Les Presses universitaires de France, 1966.).

34. Bachelard here again enters into a polemical debate with Bergson. In *Creative evolution* Bergson argues that negation does not really exist, as it is simply “an affirmation of the second degree” (Bergson, *Évolution Créatrice*, 288). Negation simply indicates the operation where “I add ‘not’ to an affirmation” (Bergson, *Évolution Créatrice*, 289). This ‘not’ should not be understood in terms of absence or emptiness, but in terms of difference. Stating ‘X is not there,’ is actually the same as saying ‘something different that X is there.’ For Bachelard, by contrast, negation is not an affirmation of the second degree, but rather an essential part of the dialectical movement of time.

35. For this reason we should make a distinction between rhythm and measure. Measure does not express the fundamental rhythm of the piece. It divides the whole piece into standard units of time, marked by the bar, but these units are simply pragmatic and secondary tools that enable the weaving of different rhythmic patterns into a complex harmony. Metronomes can indicate the measure, but they can never really describe the “fabric of time” (DD 118). They are nothing but “crude instruments,” “the magnifying glasses with which weavers count the threads [compte-fils] and not the looms themselves” (DD 117).

36. Perraudin argues that Bachelard sees the figure of the artist and the as “heroic types” as they animate the history of human progress. “These heroes benefit other individuals through their own dynamisms” (Perraudin, *A non-Bergsonian Bachelard*, 471).


38. As an example of this type of poetry, Bachelard refers to the surrealists. With their clear preference for poems that do not follow a pre-defined metrical pattern and their associative rhythmic strategies. (See DD 125-126)


A common thread that runs through the philosophies of Bergson, Bachelard and Simondon is that science is considered as a human, essentially technical practice that transforms our way to know and to act. Applying scientific principles and/or material tools transforms the world we live in and the way we understand the world and ourselves. Together with Bergson, Bachelard and Simondon I wish to explore how this act of transformation can be grasped. Each philosopher stresses different aspects of this epistemic act and how it relates the subject to the world. They aim not merely at an understanding of the already existing scientific structures, but rather at the historical transformations of concepts and categories, as well as the epistemic act of the subject itself.

Their epistemological models have therefore to provide the means to (1) access the transformations that occur in being as an object, (2) to grasp the epistemic act itself as a transformation of the human mind and (3) to conceive of the epistemic act as a technique that transforms reality. These three epistemological goals presuppose an ontology where being is in constant change and the epistemic subject has access to and participates in the transformative character of being. Otherwise transformation can neither be a phenomenon that can be perceived as an object of knowledge nor an experience of the epistemic subject that grasps itself in the act of knowledge.
The transformative epistemologies of Bergson, Bachelard and Simondon are thus based upon an ontology that allows for novelty, change and transformation. Reality is—according to them—constantly transforming itself. It seems, however, as if this implies a *petitio principii*: the transformative character of being is presupposed, while the epistemologies of Bergson, Bachelard and Simondon simultaneously wish to thematize ‘transformation.’ Change, transformation, and novelty appear to be properties of being that are shared by the human, epistemic subject. Thus, the question occurs, whether the epistemic subject can address and thematize transformations without begging the question. Or, to put it differently: why is the epistemic act to grasp transformation necessary at all, if a principle of being is transformation? Why do we not immediately grasp the first principles of being and understanding?

Although it is neither unusual that epistemology is asking for its first principles, nor surprising that epistemology is linked with ontology, Bergson, Bachelard, and Simondon provide an interesting rendition of this classical problem: they transform the classical Aristotelian question “what is a being?” into the question “what does a being do?” They are not only interested in the structures that the sciences create and what can be known within this structures (e.g. what is a substance?), but they develop—despite their different approaches—epistemologies that focus on science and knowledge as practices of transformation (e.g. how does a substance operate?). This shift to focus on operations, rather than on structures has ontological, epistemological and anthropological consequences, which I wish to explore through following three major arguments:

1. First of all, human practices are technical practices. The human subject applies concepts in order to understand itself, life, and the universe. The understanding of concepts such as “substance,” “matter,” or “energy” changes over the course of time, according to the social milieu, and according to the method one applies to fathom the phenomena. Science is thus a human practice—a technique—that applies, creates and modifies these concepts. Therefore, Bergson, Bachelard and Simondon conceive of concepts as intellectual tools. But, the tool-use is interpreted differently by each of the three philosophers. Bergson defines the human being as *homo faber*. The use of intellectual tools reduces the mobile reality to static elements. Concepts can only fathom inadequately what reality has to offer. Accordingly, scientific concepts are devoid of the dynamic aspects of reality. For Bachelard on the other hand, scientific concepts are
the starting point of realization processes. Scientific concepts, theories and techniques are necessary to realize phenomena: the scientific process creates phenomena that could otherwise not be experienced by the epistemic subject (e.g. the wave-particle-dualism). This phénoménotechnique is an essential part of scientific work. While for Bergson science deforms reality, for Bachelard, science creates new realities with its conceptual tools and allows to mobilize philosophical concepts. Therefore, the homo faber does not adequately represent the new scientific spirit. The value of tools shifts again when cybernetics enters the scene. According to Simondon, cybernetics realizes an operational technology in relating one science to another. Thus, the tools are no longer used to realize phenomena belonging to a singular science, but the toolbox is opened for other sciences. If a problem arises in a specific science but cannot be solved within its conceptual framework, other sciences and their phénoménotechnique might be helpful to pose the questions differently and/or to answer the question. Although this might be a common practice for the scientist herself, the scientific spirit of cybernetics is no longer merely interested in a phénoménotechnique, but rather in the technical operation of transposing a phénoménotechnique into a different field.

2. Secondly, change, transformation, and novelty are phenomena that can be witnessed and are studied on all levels of being. They are the expression of an élan, which is either vital, scientific or encyclopedic. The élan is derived out of the sciences themselves: for Bergson the theory of evolution provides evidence of the constant transformation of life. He introduces the concept of the élan vital to criticize a reductive interpretation of the theory of evolution. For Bachelard the development of the “new scientific spirit” shows how the transformation of Newtonian physics led not only to a new understanding of substance, matter, and energy that is relevant for the sciences, but also to a new understanding of these concepts in philosophy. Finally, for Simondon cybernetics became the scientific paradigm to inquire into a new epistemology that takes account of the operations between science, philosophy, and technology, while moreover it considers the mode of existence of technical objects in their own right.

3. Thirdly, it follows that science, technology, and philosophy operate within the realm of being. Being is not a structure that is unveiled by scientists or philosophers; rather human beings participate in the transfor-
mative character of being by means of specific forms of practices, such as
science, art, and philosophy. Scientific practice is a specific operational
mode that creates structures such as the Cartesian plane, Newton’s law of
gravity, etc. This does not, however, mean that the sciences just construct
their world, but that the sciences create structures in exchange with their
material, i.e. the world. The question as to whether or not the interrela-
tion of ontology and epistemology begs the question is—to use a famous
expression of Bergson—a false one: the epistemic subject cannot avoid
to beg the question since it is already operating within a field that exists
prior to the epistemic subject. The metaphysical presuppositions allow-
ing for transformation are thus necessary or, to speak with Bachelard, one
cannot escape one’s metaphysics: metaphysical presuppositions have im-
plications for the observation and creation of scientific phenomena and
their interpretation. The epistemological decision to address operations
in the sciences and in being originates, however, in the sciences them-
selves: (1) Bergson shows that the notion of time is reduced to a mere
quantitative term in Newtonian physics; (2) Bachelard follows the dynam-
ics of the “new scientific spirit” in the realization of phenomena that can-
not become the object of our immediate experience; (3) Simondon takes
cybernetics as point of departure and claims that cybernetics itself, with-
out philosophical reflection, is unable to create an axiology since it lacks
a proper ontology of values. This axiontology is based on the openness of
being, which is a common thread that runs through the examined episte-
omologies. Epistemology is therefore neither a synthesis of the sciences,
nor does it belong to the sciences; rather it is a genuine philosophical ef-
fort to understand human practices, or as Simondon puts it: an individua-
tion of knowledge.

All three philosophers are not merely interested in describing historical, scientific
transformations, but also in the act of transformation itself, which opens new
ways of understanding and acting: the epistemic act is transformative. Epistemol-
ogy is thus simultaneously an epistemology of transformation—an epistemology
that has as its object the historical transformations within the sciences —, and a
transformative epistemology—an epistemology that aims at the transformation
of the experience of the epistemic subject.

I will follow these anthropological, epistemological and ontological tendencies in
a transductive movement from Bergson to Bachelard to Simondon. Accordingly,
this essay has three parts. In the first part I will develop Bergson’s criticism of the sciences along the lines of the *homo faber*. The human being is conceived of as tool making animal. Science is considered as a specific human practice that has the same origins as technology. Science is therefore application-oriented and is creating stable, immobile concepts, which reduce the dynamic and transformative character of life into stable elements. The philosophical task for Bergson is to reverse the usual habit of the human intellect in order to find the origin of experience and to create “fluid concepts.” In the second part, I will show that Gaston Bachelard also sees within the sciences a technique at work, but he interprets in opposition to Henri Bergson the role of science entirely differently: science is a practice that allows to open up classical philosophical concepts. The *phénoménotechniques* of the sciences establish a recursive relationship of the epistemic subject with the world. The categories of understanding are transformed by the attempts to realize scientific phenomena. Materiality resists and returns information. The intellectual tools are not stable, but can and have to be modified over the course of time. Bachelard thus reveals the dynamic aspects of the scientific spirit and the plasticity of the human mind. Finally, I will move to Gilbert Simondon, who reacts to the challenges of cybernetics and modern technology: the focus on science and the *phénoménotechnique* shifts towards the operations between particular sciences and towards the mode of existence of the technical object. Simondon develops a conception of the human being in the midst of technical objects—and argues for the development of a “new encyclopedic spirit” that creates a new, open relation with science, technology and the world. In my concluding remarks, I would like to show, how the transformative epistemologies of Bergson, Bachelard and Simondon can contribute to an interdisciplinary anthropology.

**GOING BEYOND THE HUMAN STATE: BERGSON’S PHILOSOPHICAL TASK**

Bergson’s main metaphysical motif is transformation: life is change and evolves via constant transformations. But how can change be addressed and life in its evolution be adequately represented? Since any living being participates in life and its main task is to conserve oneself in life, all its faculties (to feel, act, and think) have to be considered in light of their vital function. According to Bergson, this means that the human intellects most important function is not to contemplate, but to manufacture “artificial objects, especially tools to create tools”: to be human means to be primarily *homo faber* and not *homo sapiens*. This definition has two consequences: on the one hand, the genesis of the human intellect is de-
rived out of its exchange with matter; on the other hand, it is application oriented. The scientific practice is therefore only one amongst other human practices. The scientist is the *homo faber* whose toolbox is the scientific method.

It looks as Bergson has formulated a circular argument: the activity of the intellect transforms reality, but a critique of the intellect is only possible by means of the intellect. But as Georges Canguilhem points out in his commentary of the third chapter of *Creative Evolution*: thought is not congruent with the intellect. The intellect is rather a habit of consciousness, a specific style of acting, which cannot generate itself, but has its roots in life itself. Even if the human intellect is manufacturing static ideas and concepts, this work is only possible due to the immediate contact with reality provided by intuition. Since intuition itself is always related to an individual in its relation to the world, intuition signifies an act of an individual. But this act is not merely an intellectual act. Intuition rather suspends the oppositions of subject and object, mind and matter or mechanism and finalism created by the human intellect. The metaphysical task of philosophy is to surpass the human intellectual conditions in an attempt to dissolve the classical oppositions and to enable thought in action, namely intuition. Bergson’s answer to the problem of the vicious circle is thus: “action breaks the circle”.

Even if one starts with the discontinued experience created by the sciences, the circle can be broken: Even when complex phenomena, such as emotions, are reduced to stable units that can be measured (e.g. heart rate, skin conductance, neuronal state, intentional object, etc.), which interpenetrate each other in the experience of the emotion, the act of understanding turns into a practice guided by the phenomenon as soon as one attempts to understand the relation between the data and the original phenomenon. The scientist needs therefore at least a certain inherent knowledge to determine a phenomenon, i.e. she needs to know what it feels like to have an emotion in order to determine that a measurement of the heart rate or a galvanic skin response might express elements of an emotion. The composition of the elements alone, however, does not lead to an experience of the whole.

Science and metaphysics differ, however, in their use of intuition. While the sciences are based upon intuition and transform experience into stable units, metaphysics uses intuition methodically and addresses phenomena in their mobility. The intuition already hinted at in the sciences leads to the proper philosophical effort, which aims to go beyond the human state and to search for the sources of
human experience:

It would be to seek experience at its source, or rather above that decisive turn where, taking a bias in the direction of our utility, it becomes properly human experience. … By unmaking that which these needs have made, we may restore to intuition its original purity and so recover contact with the real. This method presents, in its application, difficulties, which are considerable and ever recurrent, because it demands for the solution of each new problem an entirely new effort. … [W]hen we have placed ourselves at what we have called the turn of experience, … there still remains to be reconstituted, with the infinitely small elements which we thus perceive of the real curve, the curve itself stretching out into the darkness behind them. In this sense the task of the philosopher, as we understand it, closely resembles that of the mathematician who determines a function by starting from the differential. The final effort of philosophical research is a true work of integration.15

The path is ‘of experience’ has to be paved via the tools of critique. All the intellectual edifices constructed to fulfill our needs have to be reversed. Yet, this negative work is just the point of departure and the condition of an ensuing constructive effort. Since reality is constantly changing, it is necessary to make each time a new effort to grasp a phenomenon and to create each time a new method.

Bergson connects the “turn of experience” with two transformations: on the one hand, it signifies the place where the human intellect transforms the immediate into the useful; on the other, it is the proper place of philosophy to realize an integral experience from the differential and fragmented experiences. This integral experience is, for Bergson, the proper object of metaphysics, secured by a metaphysical intuition connecting the natural sciences, literature, philosophy and reality. This intuition is, however, not a mystical event that overcomes the subject as revelation. It is rather achieved through “long and intensive fellowship with the facts.”16 Therefore, it cannot be accomplished within the limits of philosophy alone. The exchange with the sciences is necessary to have a comprehensive understanding of the perspectives that are virtually possible.17 But, while the sciences can only reach a metaphorical understanding of reality, metaphysics is in search for an intuition of the things themselves. “Intuition gives us the thing whose spatial transposition, whose metaphorical translation alone, is seized by the intellect.”18
But what might be an adequate method to practice metaphysics, if the metaphorical translation of the sciences provides only a spatial transposition? Language constitutes and expresses the condition of scientific research as well as of philosophy. Language operates with concepts, which are the result of intellectual operations condensing dynamic phenomena into stable units. In this sense, they are literally metaphors: transpositions from the realm of operations into stable structures. Concepts are tools applied to reality creating structures of thought. What kinds of action are necessary to break the circle?

RECAST THE CATEGORIES, CREATE FLUID CONCEPTS!

The aim of the philosophical effort is to enable participation with the \textit{élan vital} creating sense in the universe. Bergson’s \textit{élan vital} is characterized by transformation and evolution. Philosophical knowledge is therefore a transformative act. Sense is not achieved, it is not a \textit{telos} that can be reached, but is generated:

The truth is that above the word and above the sentence there is something much more simple than a sentence or even a word: the meaning, which is less a thing thought than a movement of thought, less a movement than a direction. And just as the impulsion given to the embryonic life determines the division of an original cell into cells which in turn divide until the complete organism is formed, so the characteristic movement of each act of thought leads this thought, by an increasing sub-division of itself, to spread out more and more over the successive planes of the mind until it reaches that of speech.

The argumentation approaches its object \textit{ex negativo}: “meaning, which is less a thing thought than a movement of thought, less a movement than a direction.” Bergson attempts here to illustrate the intuition of duration in its transformative movement. We perceive separate things and locate them in order to realize that they are mobile. Yet, this movement is not merely a translocation from A to B, but presupposes a principle of movement in the universe providing a certain direction.

Bergson amplifies this description by an analogy: thought corresponds to the genesis of an organism through cell division. The origin of this process was an impulsion that corresponds to intuition on the intellectual level. The intuition reaches the level of speech (\textit{parole}) in expanding through differentiation. Speech (\textit{parole})
refers once more to the dissolution of theory and practice. The philosopher is the actual empiricist: experience is not only addressed, but it is performed and experienced in a transformative, epistemic act. Bergson’s philosophy neither starts nor ends with pre-existing ideas or structures of knowledge. It rather turns to the mobility of one’s mind in vitalizing each time ideas anew when searching for them.

Although the natural sciences also address experiences, they still act within the limits of the *homo faber*. Experience within the constraints of the scientific method is limited to simultaneity and discontinuity. According to Bergson, the sciences do not search for the turn of experience, but rather aim at measurement: “What distinguishes modern science is not that it is experimental, but that it experiments and, more generally, works only with a view to measure.”

Bergson does not deny the value of the natural sciences, nor their achievements, but he claims that their methods are inapt to address real transformations *in actu*. His central argument is that movement is divided into merely juxtaposed spatial positions and elements without considering the interval between them. Transformation is, according to Bergson, a continuous process in time that does not allow for discontinuous elements, while the sciences create laws of repetition and measurability. Continuous wholes are thus transformed into discontinuous elements. The philosophical method does not only start with an intuition of a mobile reality, it also aims at an intuition. Intuition—being the mode of immediate experience—allows for participation in transformative processes within the subject and the world. The philosophical task is, according to Bergson, to enable transformative processes in recasting the categories of human thought and in creating fluid concepts:

But to do that, it must do itself violence, reverse the direction of the operation by which it ordinarily thinks, continually upsetting its categories, or rather, recasting them. In so doing it will arrive at fluid concepts, capable of following reality in all its windings and of adopting the very movement of the inner life of things. ... To philosophize means to reverse the normal direction of the workings of thought.

The dynamic aspects of reality lead to a universal and at the same time singular experience: an intuition of the “inner life of things.” Intuition is restricted to the aspects of reality, which are fluid and in motion themselves. The aim of philoso-
Phy is to grasp the mobile reality and to create new, mobile concepts that are able to account for such things in motion.

These things in motion are grasped through an analogous motion of the mind. While working mechanically with matter, the human mind is creating ideas, categories, scientific phenomena and technical objects. In order to understand the vitality of the process, the transformation of dynamic phenomena into stable elements has to be reversed. Thus, philosophy consists in an effort to go beyond the constraints of the *homo faber*: The *homo faber* describes the operational mode of the human mind in its daily routines. These routines encompass daily life practices, body techniques, material production of material tools and the scientific invention of immaterial tools (ideas, categories). Each and every idea, invention etc. is however rooted in an intuition of a dynamic phenomenon, which is then transformed into static elements. As artificial organs technical objects are extensions of the human body that merely imitate nature, but are not producing something genuinely new and independent.

The technical world is for Bergson always related and relying on human beings. The human faculty of the intellect that creates material and non-material tools, is first and foremost interested, according to Bergson, to act on matter. The scientific and technical practices act mechanically on matter and are only able to represent matter mechanically. The sciences and technology have, according to Bergson, only a very limited understanding of matter.

Matter—as a concept of human understanding—is for Bergson the result of the human intellectual practice. The concept of “matter” is a tool the scientist uses to produce results. Bergson conceives of the scientific concept of matter as an empty, merely mechanical entity, without much ontological quality. It is a creation of the human mind. Bergson claims, however, that a different understanding of matter is possible, if one reverses the “normal directions” of our thought. The relations of human practices with matter are thus addressed through a detour: By being reversed, Bergson tries to clarify the ontological and metaphysical prerequisites of the abstract concept of matter and to achieve an intuition of the human practice in its entanglement with the world. To anticipate a Bachelardian term, the practice itself serves as an epistemological obstacle—since it has to be reversed—that is necessary to illuminate the human subject about his situation in and with the world.
We have seen that Bergson conceives of science as a specific human practice: it is a technique to extract stable elements out of the mobile reality. These stable elements can be repeatedly applied to the world and create a stable structures of thought and action. The dynamics of the human mind in applying the scientific technique can only be grasped, if this practice is reversed. Bergson points out that the positive sciences tend to build stable systems and cannot fathom transformations in action, since the sciences are constrained by their essentially technical and application oriented method. In the next part, we will see that Bachelard also focuses on the relation of technology and science, but interprets it entirely differently.

BERGSONISM DISCONTINUED: ACTIONS OF THE INTELLECT AND THE REALIZATION OF PHENOMENA

Bachelard’s philosophy seems to be the exact opposite of Bergson’s philosophy: While Bergson’s *homo faber*—in using material and intellectual tools—translates the lived, dynamic, and mobile reality into stable, immobile entities, and thus deforms the immediacy of the phenomena in their duration, Bachelard claims that scientific activity renders the conception of the *homo faber* inadequate: While the *homo faber* is adapted to the ordinary, daily life, it cannot adequately describe the scientific development of the electrical, ondulatory and acoustic thought.26 Whereas Bergson argues that to surpass the human being, one must reverse the activities of the intellect of the *homo faber*, Bachelard makes the opposite claim: modern chemistry,27 for instance, produces ideas and experiences that are not only the result of a technical realization process, but surpass also the memory, the imagination and the power of comprehension of a singular human subject.28 This means that the scientific spirit is constantly surpassing the restrictions of the human intellect and consists in a collective effort, where the social, the scientific and the technical sphere are tightly linked and thus constitute the scientific culture.29 Nature is left behind in the scientific process and human beings enter in a “factory of phenomena” when they think scientifically.30 The contemporary sciences create a new world and human beings can renew themselves in the “scientific city.”31

The infrastructure of this city is built by a constant phenomenotechnical effort to participate in the contemporary debates. The produced phenomena are no longer natural, but technical and social phenomena.32 Thus, the modern sciences for instance require an essentially social act allowing for the individual subject to
participate and to place oneself in the milieu of the contemporary polemics.\textsuperscript{33} In doing so, science cannot be (dis)qualified as either utopian, i.e. too far into the future, nor as erudite knowledge, i.e. an outdated practice unable to produce new phenomena.

This signifies an important difference to Bergson’s anthropological notion of the \textit{homo faber}. As long as human beings restrict themselves to the impressions of natural phenomena, they remain themselves natural. As soon as they leave the natural sphere, they can become objective beings.\textsuperscript{34} Furthermore, as long as they remain on their own, they stick to their developed habits, their tools and their technical routines.\textsuperscript{35} It is the rational activity of human beings that allows them to surpass themselves in opening new ways of self-understanding, objectivity and community. This quasi-humanistic argument is, however, referred back to the principle of life and receives thus an ontological quality resounding Bergson’s philosophy of life:\textsuperscript{36}

With living beings, it seems that nature is attempting facticity. Life distills and filters. The green planet, forests and meadows, make photochemistry and chemically absorb energy from the sun. But all these pre-human phenomena will be overcome when man reaches the cultural stage. The true working principle of active materialism is man himself, it is the rationalist man.\textsuperscript{37}

Even though Bachelard traces the rational activity back to pre-human phenomena, the difference with Bergson is evident: In order to arrive at an active materialism, it is necessary that human beings expand their rational practices. Human beings themselves open up materialism and create new forms of matter with and in the world. Thus, Bachelard’s new materialism goes together with an entirely different conception of the human. The \textit{homo faber} does not any longer possess a fixed and static rational structure, but is rather constantly transforming his intellect in applying his intellectual tools. Yet, the practices to produce phenomena and to open materialism are only productive, because they rely on a recursive structure: matter resists the intellect and returns information, when the human intellect is trying to grasp it. The intellect thus returns to itself with new information that initiates the change of its structure. Bachelard’s definition of the human does not return to a naïve form of rationalism. The rational does not realize itself easily and without the resistance of matter.
Bachelard exemplifies the recursive relationship of the human, rational subject with contemporary scientific conception of matter in showing that the classical relation of form and matter has been reversed:

It is matter that gives itself a form; it is matter that manifests directly its powers of deformation. Form is not any longer shaped, no longer imposed from the outside. The entire Bergsonism of the homo faber appears in its formal perspective, in its ingenious intellectualism as soon as the mixed materials thus act on each other. ... We see the multiplicity of problems a phenomenology aimed at matter raises, a phénoménotechnique constantly creating new matters (matières), an intermaterialism instructing itself in mutual reactions of various substances. Faced with the hidden nature of matter, it seems that the conscience knows that it must reform its aims, take back its distances.\textsuperscript{38}

The rational human being does not only act on matter, but matter acts upon itself and gives itself a form as well. The rational subject participates in processes of material becoming by means of a phénoménotechnique that allows her to create new matter, since it is instructed by the reactions of matter itself. This recursive relationship signifies an “era of an open technique,” which, according to Bachelard, has begun within matter itself.\textsuperscript{39} Thus, phénoménotechnique becomes the faculty par excellence of mankind to perform its transformative task.\textsuperscript{40}

THE ÉLAN OF THE NEW SCIENTIFIC SPIRIT

The human, rational activity to open up concepts is conceived of as a dialectical process inspired by the new scientific spirit. Bachelard uses the vocabulary of Bergson to express that “understanding has a dynamic axis, it is a spiritual élan, it is a élan vital.”\textsuperscript{41} His criticism of Newtonian mechanism and Cartesian epistemology is similar to Bergson’s criticism of finalism and mechanism in The Creative Evolution: (1) the new scientific spirit does not pursue a predetermined goal (finalism); (2) it does not work within a determined framework, but is interested in operative clarity. The new scientific spirit advances with respect to the “old” Newtonian and Cartesian spirit by replacing clarity “as such” with operational clarity. Being no longer illustrates the relations in being, but the relations illuminate being.\textsuperscript{42}

This “realism of relations,” as Jean-Hugues Barthélémy puts it, already anticipates Simondon’s epistemology, where being as such has no longer priority in the
sciences; rather, relations allow to think and know being. The old scientific spirit is only able to illustrate relations within being, i.e. the relations constitute a static framework, which is merely completed by the sciences, while the contemporary sciences illuminate being.

Yet, the old scientific spirit is not entirely negated. Its laws are still valid and used as epistemological obstacles by the new scientific spirit. Within the framework of the old scientific spirit it is, however, impossible to create new phenomena. The old scientific spirit can merely illustrate the relations in being and imitate what is already out there. The old scientific spirit lacks the innovative power, which is revealed in the relations within being. The relations themselves illuminate being and condition the understanding of being as operation.

This understanding of the relation of matter and scientific spirit is simultaneously Bergsonian and anti-Bergsonian: (1) The reference to the concept élan vital points to an ontology of transformation in the style of Bergson’s philosophy of life. (2) Bergson would, however, point out that life as a phenomenon cannot be grasped by definition within the framework of scientific thought. Bachelard is interested in the process of conceptualization. Concepts are not stable units, but are developed in historical acts of conceptualization. They are deformed and transformed by the spirit. Science becomes the medium to realize phenomena. Science is neither purely formal nor purely empirical. Concepts are applied to concrete experience, or rather, are virtual experiences that create the object of science. Thus, they are necessarily open and have to be transformed if they encounter obstacles in the process of realization. The dialectics between concepts and epistemological obstacles replace the old image of the relationship between a priori and a posteriori. They make the epistemological obstacles of the immediate and the general visible and operative. Scientific thought constitutes a recursive relation of theory and praxis: “To think scientifically is to place oneself in the epistemological terrain which mediates between theory and practice, between mathematics and experiment.”

Mathematics and experience are the two poles of the field of scientific thought. This field is the condition of possibility of all transformations. Only if it contains a certain tension between spirit and matter can phenomena be produced. This necessary tension already hints at the ontology of Simondon, who stresses the importance of the concept of a ‘field.’ As we will see in the next section, the clearest example for Bachelard of the importance of such a tension is the transformations
of the conception of ‘substance’ in chemistry. The historical development of this concept shows how philosophy and science influence each other reciprocally.

OPEN PHILOSOPHY AND THE PLASTICITY OF THE CATEGORIES

The exchange between science and philosophy is necessary in order to create a real philosophy of matter that goes beyond the old philosophical distinctions of idealism and realism as well as of form and matter. These metaphysical dichotomies handed-down in the history of philosophy are not apt to describe the phenomena created by the sciences. The “future science” of matter—chemistry—opens and decenters the classical, core concepts by technical means. The scientific method is no longer searching for universal, concrete substances, but rather for a systematic blueprint to realize substances. The new scientific spirit is interested in the relations within being and no longer in transcendent forms that have to be realized in each and every singular substance. For Bachelard, scientific reality is thus replaced with a dynamic process of realization. This process of realization constitutes an interplay of noumenon and phenomenon. Synthetic chemistry describes becoming as a dialogue between substance and energy in focusing on the reactions of substance.

The dialogue between substance and energy refers once more to the notion of the field. Tension between energy and substance is necessary so that material modifications can take place in being. These material modifications transform the energetic state of the substance. The dialogue is not conceived as a continuous and unitary becoming, but rather as an exchange of energies, where differences become measurable and discontinuous to one another. Energy becomes an integral part of substance and receives the same ontological status.

The interpenetration of energy and substance leads to a new, dynamic interpretation of substance. Substance is no longer the keystone of a metaphysical structure, but rather a multitude of rhythms resonating in all limbs of the metaphysical organism to spur it on:

One may even ask oneself if this structured energy, vibrant, a function of a time unit, would not be enough in itself to define the existence of a substance. In this view, substance would be no more than a multiresonant system, a group of resonances, a sort of collection of rhythms ca-
pable of absorbing and emitting certain gamuts of rays. One can foresee, in this sense, a completely temporal study of substances which would be the complement of the structural study. Obviously the door is open to all adventures, to all anticipations. Only a philosopher can rightfully suggest such adventures to the spirit of research. By this piece of intemperance he wishes to demonstrate the sudden plasticity of the categories of understanding and the need to shape more synthetic categories in order to face up to the complexity of the scientific phenomenon.49

It is within this context that Bachelard refers to a central philosophical motive of Bergson: A study of substances in terms of time. This focus on substance serves thus as an example of how Bachelard ‘opens’ a concept: (1) it shows the internal difference of the concept to its historical predecessors in the history of the science itself; (2) it draws the consequences for a philosophical and metaphysical understanding of the concept: the concept “opens” the philosophical understanding and reverberates in a different realm and (3) the whole process of creating the concept occurs in a movement from the scientific mind to the concrete experience and back: both, the human mind and the concrete, realized experience have to be open, so that transformation can occur.

This temporal study, complementary to a structural study of substance, is the framework within which the task of philosophy becomes clear. Unlike the sciences, philosophy can undertake this adventure, since it is not its ambition to determine reality in all its elements, but rather to understand the activity of the mind.50 Philosophy is therefore not primarily searching for a better understanding of reality, but aims to examine the processes of transformation in action. In proving the plasticity of the categories of human understanding, philosophy becomes relevant for the sciences: the philosopher provides a theoretical foundation for the scientific practice where theory prepares concrete phenomena and is corrected by experience. The foundation itself is not unchangeable. The transformative nature of the new scientific spirit also applies to metaphysics and philosophy:

In a philosophy of no a new metaphysical shade of meaning makes its appearance in the notion of substance. In order to underline forcefully the fact that substance is defined by a group of external determinations, arranged in such a way that they cannot together achieve enough precision to acquire absolute interiority, one might perhaps enlist the term existence. Accordingly, sub-stance, sur-stance, ex-stance, such would be—for
want of a better term—the play of pure concepts necessary for the classification of all the tendencies of metachemistry.\textsuperscript{51}

This quote clearly shows the recursive relationship of philosophical reflection and scientific practices. If philosophy wants to play a part in the production of knowledge, it has to deal with the sciences. The philosophy of no has to open up and to create concepts to identify and highlight the transformations in the sciences. This means that, for instance, the notion of substance can always receive new metaphysical nuances. The point of departure of this process of opening (\textit{ouverture})\textsuperscript{52} is an epistemological obstacle. The concept of substance blocks the path of the new efforts of realization. Within the new scientific framework, the classical understanding of substance can no longer be realized. It has to make way for a new, open form of conceptualization: “The process here is from a closed, blocked, linear conceptualization to an open, free, many branching, conceptualization, free from the fusion of experience and primitive thinking.”\textsuperscript{53}

This does not mean, however, that philosophy becomes the subservient to the natural sciences and its ontology; rather, through the sciences new ontologies become possible. This creative and transformative potential cannot be found in stable metaphysical systems where the final goal or a comprehensive reality is pre-given. Epistemology has to become as mobile as the scientific spirit.\textsuperscript{54} Philosophy consists in a process of thought that is constantly in search for its object, challenges its own categories, and abandons them when their potential to realize phenomena is lost.\textsuperscript{55} The task of the philosopher consists in a constant effort and exercise to modify axioms:

But this coherence must be lived through in its proper place by the philosopher; it is not automatic, it is not done easily. The philosopher who wants to learn surrationalism cannot come to it all at once. He must experiment by opening up rationalism in successive stages. He must seek out the axioms to be dialectized one by one. Just one dialectized axiom brings all nature out in choral song. In my own experience, surrationalism, I have found, never has more than one sharp or one flat in its key-signature.\textsuperscript{56}

The philosophical work on concepts is a collective and interdisciplinary act: Philosophical concepts are developed in contrast to and in dialogue with other philosophical positions. The sciences, however, apply concepts and test their concrete performativity in order to create experiences. These processes of transformation...
are the primary subject of philosophy, where concepts can be created that do not only leave impressions in the academic armchair, but are efficient in their realization and produce phenomena. Opening a concept thus goes into two directions: It opens the concept internally, i.e. the concept is dialectized (dialectisée), and the spectrum of meaning within a concept is thus enlarged, while simultaneously the experience is specified (précisée).  

Philosophy consists thus in an effort to search for and to establish the recursive relationship with the sciences. We have seen that Bachelard—as Bergson—formulates the goal of philosophy as a surpassing of the constraints of the human intellect. In contrast to Bergson, however, the concept of matter in the sciences is not abstract and devoid of dynamic elements, but rather the result of the recursive relationship of the scientific human mind with matter. The confrontation with the sciences allows us to open up philosophical concepts. The sciences play, so to speak, the part of epistemological obstacles for the philosopher that are necessary to leave its preconceived ideas and categories behind.

SIMONDON’S EPISTEMOLOGY OF CYBERNETICS OR THE NEW ENCYCLOPEDIC SPIRIT

This recursive characterization of philosophy is also at stake in Simondon’s interpretation of cybernetics. Philosophy, Simondon tells us, is not a specific domain or area that can be delimited. It is not an application of a specific form of thought to defend spiritual or temporal interests. Its function is rather to be open to foreign domains, in which problems of human existence arise, in order to ascertain, actualize and examine the problem. This new problematic occurs in what Norbert Wiener calls the “no man’s land” between the sciences. But here, it is no longer science that challenges philosophy to rethink its categories but the development of new techniques. On the one hand, machines have received an autonomy and do not need the human being as source of energy anymore. On the other a science can itself become a technique: when a problem in a specific scientific field arise and another science is as technique imported to solve the problem.  

These new techniques are closely bound to the development of a new conception of the human. Simondon’s critique of the homo faber is analogous to Bachelard’s, but goes in some aspects even further: for Simondon, cybernetics and the theory of information have shown that technical objects have a mode of existence that is independent of the homo faber.  A unilateral relation of human beings to tech-
towards an interdisciplinary anthropology?

...
operations by inventing structures.” It is important to note that the French en inventant points to a simultaneity of structure and operation. Science invents operations and simultaneously determines objective structures. Techniques invent structures and produce simultaneously operations, e.g. the invention of the motor is the invention of a structure that produces a specific operation, which defines it as a motor.

This diametric relation of science and technique as well as of structure and operation illustrates in a nutshell the new problem that arose with cybernetics: due to the particularization of the sciences, a multitude of methods and operations exist next to each other. Universal geniuses, such as Leibniz, who had a comprehensive grasp of the sciences as such, do not exist anymore. Rather, specialists delimit their specific fields and are not interested in the neighboring field. The question for the cyberneticists—and also for Simondon—was, how do the sciences relate to one another? Is there a general method that allows for movement from one science to another?

THE NO-MAN’S LAND AND THE ALLAGMATIC METHOD

Simondon interprets cybernetics as the science capable of performing this task. But as opposed to Norbert Wiener, whose metaphor of the no man’s land suggests that a proper domain of cybernetics exists, Simondon claims that cybernetics might evolve into a similar compartmentalized science developing branches of cybernetics, such as servo-mechanics, a theory of influx etc. Instead of searching for the promised no man’s land, cyberneticists should realize that they just have a complementary view of the “same” world. The philosophical task, which Simondon derives out of the discussion of cybernetics, is therefore to “invent a new structural notion allowing to develop an universal allagmatic.”

This new allagmatic is the “method of operations.” It is “symmetrical to the theories of structures in the particular sciences.” Whereas the “sciences” deal with “structures,” the allagmatic method searches for the realms where these operations take place. The allagmatic method is marked by its two constitutive modes: on the one hand, it has “operations” as its object; on the other, it has to be itself an “operation” that provides communication between formerly separated levels of being.
Due to its interest in feedback mechanisms and exchange of information, cybernetics addresses these operations on a different reflexive level than the particular sciences. Simondon defines the work of the particular sciences in Bachelardian terms:

However, science aims, in each domain, at a theorization of experience. The scientific gesture is free. Only the theoretical result of this gesture matters. The operational activity of science has in each domain only one control: the compatibility with experience, therefore with the object.\textsuperscript{76}

The scientific gesture realizes the compatibility of theory with experience, of the abstract with the concrete, of mind and object. This relation signifies the knowledge of an isolated system. Science “determines objective structures,” as we have seen above. A new, different mode of knowledge must therefore be developed to open the isolated systems to one another. This \textit{inter-} or \textit{super-scientific} knowledge is, according to Simondon, universal technological knowledge (\textit{savoir technologique universel}):

Within the operational inter-scientific if not supra-scientific compatibility a mode of relation to the object is discovered, which is no longer scientific but technical. The technical subject-object relation is richer than the scientific relation. The latter is abstract and concerns a limit case of an object not modified by the realization of consciousness and without relation to the world (isolated system). The technical relation on the contrary considers the object in its concrete totality of its aspects, in its relation with the subject of knowledge and the world. The \textit{no-man’s land} in between the particular sciences is not a particular science itself, but a universal technological knowledge. An inter-scientific technology that does not considers a theoretical \textit{object}, cut out of the world, but a \textit{situation}.\textsuperscript{77}

While the scientific object is merely considered in its relation to the knowing subject, the technical object is considered in its relation to both the world and the knowing subject. Focusing on the relations between the sciences, or entering \textit{no-man’s land}, opens a specific science in relating it to the world that surrounds it. Due to its technical structure, the operations at work on different levels of being can be addressed. This does not, however, mean that one operation is reduced to another, but that operations can be \textit{equivalent} to one another:
One can call a situation equivalent to another, if the same technical gesture modifies both situations in the same way. Equivalency is not an identity of the nature of objects, but an operational activity, which has to be exercised on them [the nature of the objects] to modify them in the same way. It is an analogy, if one understands analogy as a relation not of identity (resemblance or similitude), but as identity of relations, and to specify, operational relations.78

The technical gesture, which modifies a specific situation, allows us to relate different domains to each other. It is, however, important to note that it is a technical gesture and not a technical structure that allows for equivalency. Although structure and operation are, according to Simondon, complementary to each other, operation nevertheless has priority.79 The technical gesture is therefore an operation of its own that relates different operational modes with each other. It leads to the philosophical gesture, which, according to Simondon, aims at grasping the moment where structure turns into operation or operation turns into structure. This transformative experience is the “cogito of a new, reflexive philosophy”:

This cogito of a new reflexive philosophy, where the function grasps itself in its functioning, allows, after the ontological culmination, which marks the equivalency of being and acting, between operation and structure, to found an axiology. According to the cybernetic method, the only valuable axiology is an axio-ontology.80

This “axio-ontology” cannot, however, be derived from cybernetics itself, since there is still a crucial difference between cybernetics as a science and philosophy. As already mentioned, the operational mode of philosophy is not exclusive. It does not delimit its proper domain in contrast to other domains, but is in its essence open and able to change its structure. This openness is precisely how Simondon defines value: The change or transformation of a structure.

THE NEW ENCYCLOPEDIC SPIRIT

Yet, structural change only occurs, if a “thanatological element” enters a holistic system and creates a problem, which threatens the living being in its existing structure. This thanatological element cannot be grasped with the concepts applied by cybernetics to describe vital processes—namely negentropy and homeostasis—since they represent merely a function respective to a teleological mechanism
of the living being. The living being, thus defined, does not change its structure, but increases it’s organization (negentropy) to remain the same (homeostasis). Simondon turns cybernetics against itself: although cybernetics is right in addressing the question of information, it cannot formulate the question adequately in its own terms when it comes to living systems. Here, a non-probabilistic conception of information becomes necessary, in order to explain how a specific form is of higher quality in a specific holistic system or why a system needs to change its structure.

This qualitative notion of information is rendered possible by the philosophical effort, which makes a certain problem within a domain conscious that cannot be resolved within the domain by itself. Insofar, philosophy operates in analogy to cybernetics. The philosophical effort leads, however, not only to a consciousness of the system itself, but it also opens the system in providing culture. Culture in return, is defined as contact with a universal totality of systems, a contact with an “imaginary or real holistic system” capable of incorporating all other systems. The philosophical effort thus solves a particular problem in integrating it in a general problematic and opening it for other systems:

The philosophical effort therefore provides a contact with a real universality. It integrates a system hitherto isolated in the immense society of systems. It solves a particular problem in integrating it in a general problem and it makes the solitude of problems cease to create a world of problems. It opens thus a system to relate it to others, due to a change of plan. The philosophical effort modifies in its encyclopedic intention in the Hegelian meaning of the term the individuality of the problems in striving towards the most synthetic and highest problem.

While a problem remains bound to a specific situation and has—since problems arise only for living beings, i.e. individuals—individuality, the philosophical effort can relate it to a different, higher, and more abstract sphere. This does not mean that the individuality of the problem is lost, but that it is posed in a different, metaphysical way. The encyclopedic intention is that the individual understands the problem itself and relates it to a higher holistic system. The holistic system to which the individual relates is neither given in advance, nor is it a system that realizes itself during the course of history. The axio-ontology is not based upon the existence of the higher holistic system, but on the ability of the individual to perform the technical, scientific and philosophical gestures: to grasp itself and its
relation to the world in the act. The value, the new axiomatic structure of operations is based upon, is the transformative character of being itself. This capacity is found, according to Simondon, in the individual itself prior to any distinctions.\textsuperscript{87} Within the individual, a structure and operation are intrinsically linked without reducing one to the other. Within the individual both, structure and operation, are convertible and equivalent to each other.

The epistemological task is to facilitate transformative operations in a philosophical gesture in its encyclopedic intention. The reference for Simondon to develop a “new encyclopedic spirit” does not, however, only come from Hegel, but also—and more importantly—from Diderot and Alembert, as well as from the Sophists in Antiquity, from Plato, and finally from the modern cyberneticists.\textsuperscript{88} The encyclopedic spirit has, therefore, a certain methodology: Its central point is that it allows for a general public access to technical knowledge. In doing so, it aims, according to Simondon, at a unification of operations and is itself a tool allowing individuals to reinvent and actualize technical gestures.\textsuperscript{89} It consists of a description of tools, and technical apparatus is not restricted to written language, but uses plates, graphics and schemata to allow as many recipients as possible to participate in the technical developments. Its recipients and the form in which the technical operations are interpreted are not yet defined, but are virtual and open.\textsuperscript{90} The encyclopedia applies an operation, namely schematization, to instruct its reader of its operational mode.

Simondon describes the encyclopedia as a machine that needs to be reinvented by a human gesture:

All encyclopedic machines necessitate and call for a human gesture to put them into action: the shape of the \textit{pinax} is followed by the finger or by the look, indentation after indentation; one pores over the book, since it refers from one article to another; one commands an automatic filing system starting from a central platform. But to consider the \textit{pinax} statically, to read a printed encyclopedia alphabetically, to let an automatic filing system work by chance, means to consider operational machines structurally and not to account for its encyclopedic meaning. The modern encyclopedists are the modern scientist, that is the cyberneticians, these technicians of information, who work in teams and think communally, driven by their faith in this new postulat: logical empiricism.\textsuperscript{91}
The epistemological task comprises three elements: (1) the encyclopedia is described as a machine that calls for a human gesture. The pinax, in this case the writing tablet of Thales, has to be touched or perceived: the book is pored over, since its articles are an integral part of a system of references that have to be understood as specific operational mode of the encyclopedia. One navigates through a data system starting from the home screen: structure and operation belong here together. Although structure is necessary, it is not preferred over and against operation. (2) The gesture requires a specific, epistemological attitude towards the encyclopedic machine to be realized. One has to search for the operational mode and fathom the machine in analogy to oneself in order to understand it. Neither book, nor computer, nor basic writing tool can be considered merely as structure. Understanding the machine in analogy to oneself leads therefore not only to a genuine understanding of the machine, but also to a better self-understanding. The encyclopedia signifies a machine that mediates the production of a new perspective. (3) The encyclopedic spirit is a collective, interdisciplinary effort. It facilitates the operation to relate the individual to different technical and intellectual systems. The compartmentalization of the sciences necessitates this collective effort. An individual scientist is no longer able to comprehend all the methods that are at work in the particular sciences. Cybernetics is thus a role model of interdisciplinary research: it is not interested in the definition of a particular field, but its operations attempt to understand “control” and “communication” as such, without being limited to a specific domain. The collective effort is the philosophical gesture as such, attempting to relate to universality, yet this universality is not a closed system, but the mode of operation of individuals in their tension with the milieu as such.

Simondon combines in an original way the epistemologies of Bergson and Bachelard. While he still holds that sciences tend to develop isolated systems—an argument echoing Bergson’s criticism that the sciences transform the mobile reality into stable elements—, Simondon is also aware of the productive aspects of the phénoménotechniques of the sciences and the dynamic character of the scientific mind as well as of technology. We have seen that he focuses on the technical gestures and operations themselves that do not only allow to realize phenomena, but also to mediate between the sciences: Operations he exemplified and sees at work in the encyclopedic spirit.
CONCLUSION

The transformative epistemology, I described in this article, followed different forms of an élan: it moved from the élan vital to the élan scientifique to the élan encyclopédique. I attempted to show that each of these epistemological movements consists itself in an operation, an epistemic act, which can open and transform static structures. This act ties anthropology, epistemology and ontology together: epistemology does not occur in an abstract realm, but is, as are scientific practices, realized by a subject in the world. This “applied metaphysics” of Bergson, Bachelard and Simondon, invites the human subject to participate in the transformations of life and knowledge.

Although the differences between Bergson, Bachelard and Simondon are significant, all three of them are advocates of a transformative epistemology of openness. Their philosophies are inspired by a humanistic impetus that challenges human beings to understand themselves in their relationships with their scientific, social and technical environments. Their epistemological projects address human practices on different levels and relate them to each other. This effort to relate different domains to each other, can be understood as interdisciplinary anthropology: the human is no longer considered from an essentialist vantage point. The anthropological question is, within this interdisciplinary anthropology, not “what is the human being?,” but rather “what does a human being do and what are its relations to and with the world?” This praxeontological move emphasizes the necessity of the human subject to create symmetry between different types of being, rather than sacrificing it for a transhumanist position.

Reading Bergson, Bachelard and Simondon together provides thus a methodological reflection on the conditions of possibility of an interdisciplinary anthropology that addresses human practices within and in between the different sciences. I therefore understand interdisciplinary anthropology not as a particular discipline or as a preconceived method, but as a philosophical effort to raise, develop and pose the anthropological question in exchange with the sciences.

Bergson, Bachelard and Simondon show that this effort is a necessarily open endeavor: It relies upon an ontology that allows for openness, transformation and symmetry. Epistemology and philosophy are not excluded from the constant transformations of life and mind. This means in turn, that the epistemological project is necessarily open. The epistemic act is not merely transforming the rela-
tion to the world, but also transforms the subject itself and provides the means in its encyclopedic effort to create new modes of humanism.\textsuperscript{95}
NOTES

1. Ultimately, this is the classical problem of Aristotle’s *Metaphysics*. Aristotle uses the famous analogy of the nektyris (bat or nightowl) to describe the relation of the human intellect to its first principles: “Just as it is with bats’ eyes in respect of daylight, so it is with our mental intelligence in respect of those things which are by nature most obvious.” Aristotle, *Metaphysics*, 993b9.


8. I am aware that Bergson rather uses *intelligence* than *intellect*. *Intelligence* indicates a natural, immanent faculty that came about in the course of the evolution of life. *Intellect*, however, implies the Aristotelian transcendental faculty. Yet for Bergson, intelligence/intellect does not imply a hierarchical distinction. Instinct and intelligence/intellect are for him, although they differ essentially, two solutions of vital problems. I chose to use intellect rather for reasons of coherence with the English translations (who from time to time translate intelligence with intellect or with intelligence), but I ask the reader to keep the immanent character of the human intellectual faculties in mind.


17. Philosophy and science both are collective efforts that share a methodological impetus of constantly adapting to the phenomena: “For in this view, philosophy is no longer a construction, the systematic work of a single thinker. It needs, and unceasingly calls for, corrections and


27. Although any particular science, such as physics or biology, can produce new ideas and impact philosophy, chemistry was particularly important for Bachelard. Cf. Christina Chimisso, “A matter of substance? Gaston Bachelard on chemistry’s philosophical lessons” In: Galavotti, Maria Carla; Nemeth, Elisabeth and Stadler, Friederich eds. *European Philosophy of Science - Philosophy of Science in Europe and the Viennese Heritage*. Vienna Circle Institute Yearbook, 17. Springer, 2013, 33–44.


36. Jean-Jacques Wunenburger points out that both Bachelard and Bergson refer to a primitive force in the universe even though they differ in significant points: “Chez Bergson, l’action d’une force primitive dans le cosmos ou dans la Nature est ainsi censée se prolonger dans la conscience, qui puise dans ce dynamisme la capacité de mobilisation et de créativité psychique towards an interdisciplinary anthropology? · 131

37. Bachelard, Matérialisme rationnel, 32f [Translation J.F.M. Schick].
38. Bachelard, Matérialisme rationnel, 16 [Translation J.F.M. Schick].
40. Bachelard, L’activité rationaliste dans la physique contemporaine, 4.
41. Bachelard, Nouvel esprit, 179.
42. Bachelard, Nouvel esprit, 148.
43. Jean-Hugues Barthélémy, Penser l’individuation. Simondon et la philosophie de la nature, Paris: L’Harmattan, 2005, 20. This is also the case for Michel Serres as Massimiliano Simons shows in his contribution to this Special Issue.
47. Bachelard, Le matérialisme rationnel, 24. Bachelard shows that chemistry is in need of what he calls a “metachemistry,” just as physics has its metaphysics. This metachemistry would have the same relation to metaphysics as chemistry to physics (Bachelard, Philosophy of No, 45). Metachemistry and metaphysics are the conditions of possibility of a science to critique its own foundations. In the case of chemistry the metaphysical or better ‘metachemical’ presuppositions, are changed in the transition from seeing chemical substances as bodies that can become objects of our immediate experience to seeing them as products of scientific and technical means. The transformation of the concept of substance within chemistry thus shifts from a naive, prescientific realism towards a mature scientific concept. From the latter perspective, the immediate experience does not have to correspond with the scientific experience. The new concept of substance structures our experience and enables a phenomenon that contradicts the intuitions of our daily life. Moreover, Bachelard claims that within chemistry existence is never a monotonous function, but rather allows for a multitude of tones (Bachelard, Philosophy of No, 46). A specific substance is therefore not always constituted in exactly the same way, but it can vary on different levels and does not have any predetermined coherency. For a study concerning

48. Bachelard, Philosophy of No, 56.
49. Bachelard, Philosophy of No, 58f.


51. Bachelard, Philosophy of No, 66.


53. Bachelard, Philosophy of No, 113f.
54. Bachelard, Rationalisme appliquée, 10.
56. Bachelard, Philosophy of No, 118.


58. Simondon uses the term “technique” to address technical phenomena in general. He makes, however, the important distinction between “technique” and “technologie” to describe cybernetics as a science of techniques (Gilbert Simondon, “Cybernétique et philosophie,” 40).

60. Simondon, Mode d’existence, 11f.


64. Simondon, “Cybernétique et philosophie,” 38.

66. Simondon, Individuation, 40f. Simondon explains in his thesis on individuation (first published 1964) using the production of a brick as example that the process of individuation cannot be reduced to a relation of an ideal form and pure matter: the materiality of the form takes as well part in the process of production as is the specificity of the material filled into the form. Form and matter entertain an intricate, recursive relation while the brick is produced. That means, matter has to be prepared and informed in the process of production.
Simondon, “Épistémologie de la cybernétique,” Sur la philosophie, Gilbert Simondon, 186 [Translation J.F.M. Schick].


Simondon, “Épistémologie de la cybernétique,” 185.

Simondon, “Épistémologie de la cybernétique,” 185.

Simondon, “Épistémologie de la cybernétique,” 185.


Simondon, “Allagmatique,” 529 [Translation J.F.M. Schick].

Simondon, “Cybernétique et philosophie,” 40f [Translation J.F.M. Schick].

Simondon, “Cybernétique et philosophie,” 41 [Translation J.F.M. Schick].

Simondon, “Cybernétique et philosophie,” 42 [Translation J.F.M. Schick].

Simondon, “Allagmatique,” 534. This preference of operation is based upon Simondon’s ontology, which is intrinsically linked with epistemology and the methodical use of analogy. The concept of analogy hinges for Simondon on the understanding of being: beings have to be inseparably linked to their mode of action—their operation—in order to apply the “method of analogy.”


Wiener, Cybernetics, 11.


Simondon, Individuation, 213f.

Simondon, Individuation, 535.


94. I will restrict myself to the epistemological aspects of the works of Bergson, Bachelard and Simondon. I will therefore not discuss “imagination” and the poetics of Bachelard, although, as for instance Jean-Jacques Wunenburger points out, both sides, the epistemological and the poetic side of the human mind are for Bachelard part of an integral anthropology (Jean-Jacques Wunenburger, “Bachelard, une anthropologie de l’homme integral,” in: *Altre modernità. Rivista di studi litterali e culturali*, Milano, Università degli Studi di Milano, 2012). I follow, however, Francesca Bonicalzi, who stresses the “point vélique” in Bachelard’s work to argue for the ethical and anthropological consequences of Bachelard’s epistemology of openness (Francesca Bonicalzi, “Gaston Bachelard: épistémologie ouverte et éthique de la connaissance” *Gaston Bachelard: Science et poétique une nouvelle éthique?* Jean-Jacques Wunenburger (ed.) Paris: Éditions Hermann, 13). I am aware that my account of an interdisciplinary anthropology cannot be comprehensive, since I limit myself to specific aspects of the aforementioned philosophers. An excuse, even if it is a weak one, might be that interdisciplinarity is always a practice that has to be created in a concrete situation.

95. I argue that interdisciplinary anthropology, as I have presented it, also subverts the classical oppositions between nature and culture as well as nature and technology. Jean-Hugues Barthélémy presents a similar argument, but is far more critical of “anthropology”: Jean-Hugues Barthélémy, “What New Humanism Today?” *Cultural Politics* 1, 2010; 6 (2), 245.
INTRODUCTION

Let me arrive at Bachelard by a short detour that will take us far away from his interests while still remaining close to his way of thinking. In 1746 in his *Essay on the Origin of Human Knowledge*, Etienne Bonnot de Condillac, “the French Locke” as he is sometimes called, develops an objection against Descartes’s methodological doubt. For Condillac, Descartes’s deconstruction of acquired knowledge eventually fails to clear the ground on which true knowledge is supposed to be rebuilt:

Descartes was right to think that in order to gain certain knowledge we must begin with the rejection of all the knowledge we believe we have acquired; but he was wrong when he thought that it was sufficient to doubt that knowledge. To doubt if two and two are four, whether man is a rational animal, amounts to having ideas of two, of four, of man, of animal, and of rational. Thus doubt leaves the ideas subsisting such as they are; therefore doubt is no remedy, since our errors have their source in wrongly framed ideas. It can make us suspend judgment for a while, but in the end we do not escape from uncertainty except by consulting the ideas which doubt has not yet destroyed, and it follows that they will lead us astray as before if they are vague or poorly determined. So Descartes’ doubt is ineffectual.
Indeed, for Condillac Cartesian doubt is not radical enough, as it only reaches the validity of our ideas, leaving their “material” intact. Such doubt is “useless” (in the citation above, Hans Aarleff translates “ineffectual”) for it is too superficial. Since the very bases of our ideas fail to be attained, what was put into quarantine recovers altogether and regains its initial form, which is falsely rehabilitated because it was never truly challenged.

A very simple idea can be preserved from Condillac’s argument: to credit some piece of knowledge with the mark of invalidity is not always sufficient for eliminating it, even temporarily, from our mind. If I wish to highlight the fact that the same observation is inherent to Bachelard’s work and, as we shall see, even explicitly commented by him, it is not because my intention would be to set this view at the heart of Bachelard’s epistemology. I believe nevertheless that by focusing on the resistance deployed by diverse elements of science that were disallowed as invalid, we are susceptible to expanding historical epistemology’s range of competency. Amplified in this sense, and with the help of an entirely internal source of Bachelardian epistemology, historical epistemology could find itself “symmetrized” and, by the same way, markedly strengthened.

THE “POLYMORPHIC” NATURE OF THE NOTION OF “EPISTEMOLOGICAL OBSTACLES”

*The Formation of the Scientific Mind* (1938) offers an inventory of epistemological obstacles that the human mind, but also the mind of presumably every individual, has (had) to overcome on its way to scientificity. This, at least, is how Bachelard’s book is usually presented: Bachelard identifies what obstructs the advent of science, and what keeps the mind in its ante-scientific condition. Although the list that Bachelard establishes is not intended to be exhaustive, it is meant to be representative enough to place the new object of the epistemological obstacle on the map of relevant epistemological problems.

Cristina Chimisso is certainly right to point out that *The Formation of the Scientific Mind* is basically not about the progress of the scientific mind or of science itself. Bachelard is nevertheless certainly not rejecting the idea of progress: in effect, he claims allegiance to the 19th-century French positivist Auguste Comte and finds inspiration in a Comtian hierarchy of different, historically constituted manners of knowing. In a way, Bachelard extends Comte’s three-stage model: if the theological and metaphysical periods in the history of human knowledge laid down
by Comte find themselves dissolved by Bachelard into a single pre-scientific era (stretching from Antiquity to the 18th century), then the Comtian positive stage is, on the contrary, split in two by Bachelard’s distinction between the scientific mind (from the end of 18th century to the beginning of the 20th century) and the stage of the *new scientific mind* launched by Einstein’s theory of relativity and unknown, of course, to Comte. We can here leave out the question whether the principles of Comte’s epistemology make it ready for such a development. In any case, in *The Formation of the Scientific Mind* Bachelard considerably reduces the real scope of his analysis when he places himself on the very edge of pre-science so that he might observe and qualify its inertia.

Alongside to the image of a barrier preventing the advent of science, another understanding of Bachelard’s concept of the epistemological obstacle can be put forward, and the global appreciation of *The Formation of Scientific Mind* consequently modified. It is Dominique Lecourt who, in *Gaston Bachelard’s Historical Epistemology*, points out—rather inconspicuously indeed—that the place of the epistemological obstacle in the knowledge process is susceptible to variation:

> It can arise at the moment of the constitution of the knowledge, or at a later stage in its development, once it has already been constituted as a scientific knowledge. In the first case it can be said to be a “counter-thought,” in the second a “suspension of thought” (*arrêt de pensée*). [...] In other words, I shall say that in one case [the epistemological obstacle] prevents scientific thought from arriving, in the other, when it has already arrived, it demotes it to the rank of ordinary thought. For everything, ultimately, amounts to the re-establishment of the broken continuity between scientific thought and ordinary thought.\(^6\)

I find this distinction remarkably far-reaching. Lecourt emphasizes that in both cases the obstacle stems from pre-science. In both his versions, the function of the epistemological obstacle is the same, as it corresponds to “a point of resistance of thought to thought”\(^7\). This conflict can nevertheless occur in two different situations that assign to the epistemological obstacle the role of either obstructing scientific thought in the process of seizing power, or of intruding ordinary thought—in fact the term *non-scientific thought* sounds to me better suited to the variability of historical examples that Bachelard discusses—into science as already constituted. In this second sense, then, instead of preventing the advent of science, the epistemological obstacle *causes* a local impurity within already-
established science.

It is crucial to realize that for Bachelard, this intrusion of the past (within the general historical framework that Bachelard sketches, pre-scientific thought indeed acquires this temporal locus) into the “present” (i.e. into scientific knowledge) can occur despite the scientist’s vigilance. It is precisely this insight that calls to mind Condillac’s critique of Descartes referred to in the introduction of this paper. By the same token the “no” so valued by Bachelard since it is required by all scientific renewal shows its problematic side.

EXAMPLE 1: RATIONALIZATION ON AN ABSURD BASIS

Unfortunately, and it would be unfair if we forgot to mention it, illustrations of “ordinary thought” contaminating scientific knowledge already constituted are quite rare in The Formation of the Scientific Mind. We will look at two examples of this manifestation (should we say type?) of epistemological obstacle, which Bachelard treats in some detail even though he does so as part of his general search and without distinguishing between them and obstacles of the first kind (i.e. obstacles to the arrival of scientific thought).

The first example is drawn from the history of medicine and pharmacology. In chapter VII of The Formation, which engages in “psychoanalyzing realists,” Bachelard discusses the issue of abusive transfers of the economic value that certain materials, such as gemstones, habitually acquire, which used to result in their valorization within contexts a priori disconnected from the sphere of merchant exchanges. Precious stones are thus empowered with precious healing powers that ensure them an astonishing longevity within pre-scientific medicine: “Even when a critical spirit comes into being, it still respects the value it is attacking. [...] Even when beliefs are denounced as superstitious, they have to be looked at a second time in order to be sure that the writer is rid of them.”

The hesitations of the French chemist and physician Étienne François Geoffroy (1672–1731) are discussed by Bachelard as a representative example of this arduous conversion to scientificity: Despite his doubts about the merit of traditional theories regarding the therapeutic powers of precious stones, Geoffroy fails to truly put these age-old speculations aside. Even if he has a clear idea about the superstitious nature of these theories, he decides to retain what he presumes to be their robust core. For Geoffroy, in spite of the lack of evidence, the wisdom of
the ancients must be preserved:

“We must not therefore proscribe precious stones from Pharmacy’s compositions without good cause,” he affirms, “for they have been accepted for many years and approved by long and blessed patience.” And so we have to respect a science we do not understand!

As Bachelard remarks, Geoffroy shows himself just as respectful towards the knowledge of Arabs who attributed curative virtues to the gold. Gold’s beneficial qualities are explained by Geoffroy with arguments nourished by the force of analogy, artfully mixed with modern materialism: the Sun restores life to all of nature; the Sun is the source of the sulphur contained in the gold; gold, which is incorruptible, preserves blood from all corruption when it is mixed with it, and restores human nature just as the Sun does. Nevertheless, as Bachelard points out, Geoffroy hesitates before accepting these propositions. And this hesitation is, in the eyes of Bachelard, the very sign of continued subjugation to the pre-scientific mind:

Geoffroy is no doubt reluctant to accept such convergences; however, this reluctance is in fact characteristic of the pre-scientific mind. It is this reluctance that prompts us to say that pre-scientific thought is encountering an obstacle here which, while not yet surmounted, is in the process of being so.

Despite these words, which seem to keep Geoffroy outside the bounds of scientificity, Bachelard doesn't really feel the need to settle whether Geoffroy should still be counted among the ancients. Mainly, he is curious about Geoffroy’s hesitation, which possibly situates him “in-between” the two epochs, which is an excellent position from which to observe the hard (and basically collective) work required in order to overcome “superstition.”

Realism prevents Geoffroy from abandoning an ancient theory that he would have all the reasons to dismiss. It is indeed this very fact that, in this example, traditional knowledge is not allowed to enter uncritically, which conducts me to interpret it as an illustration of the “epistemological obstacle” accepted within its second meaning (i.e. as having for effect the intrusion of the ancient knowledge into new science). Although preserved, the past knowledge is revised and transformed. Bachelard affirms this very explicitly: Geoffroy’s case illustrates the
situation in which “more or less accurate experience joins up with completely erroneous tradition despite very strong criticism.” Critical distancing is already at work, and even if it fails, it is not without effect:

Writers first of all feel the need to note these beliefs, for keeping silent here would doubtless disappoint their readers and breach the continuity of culture. Then however—and this is more serious—writers often take upon themselves the task of partially rectifying these beliefs, thus bringing about a rationalization on an absurd basis...

On the basis of this example, I would like to formulate the hypothesis that the science of the past does not infiltrate the new science in any simple way, but penetrates it transfigured (and that, of course, makes it more difficult to track).

EXAMPLE 2: INVALID INVALIDATION

Let us come to our second example of epistemological obstacles that disrupt the scientific thought, and cause the “induration of old beliefs.” Bachelard’s discussion, in chapter IV of The Formation, of the “abusive extension” of the image of sponge offers a new insight into the mechanism of contamination of the new by ancient stereotypes. First, Bachelard describes the attractiveness of the term:

We now wish, in this short chapter, to be even more precise and consider an instance where a single image or indeed a single word constitutes the entire explanation. [...] Here though we shall be taking the simple word “sponge” and seeing that it allows the most varied of phenomena to be expressed. And because we are expressing these phenomena, we believe we are explaining them. We believe we know them because we recognize them.

The function of the sponge is so clear that it doesn’t call for explanation; the sponge is thus ready for use as an explanans. René-Antoine de Réaumur’s account of the compressibility of air provides a good illustration. Bachelard extensively quotes from Mémoires de l’Académie royale des Sciences (1731) in order to show how willingly Réaumur accepts the image of sponge when arguing against Mariotte. But the most interesting moment in Bachelard’s analysis comes with the next step, when Réaumur seeks more liberty for the term “sponge,” claiming that a “sponge of the air” can of course be dissimilar to an ordinary sponge. Bachelard
Yet all his thought has developed from this image and cannot leave its primary intuition behind. When he wishes to erase the image, the image’s function remains. [...] In other words while he is in the end very willing to sacrifice the sponge, he wishes to keep spongiosity.

As a matter of fact, Réaumur refrains from raising the question of the composition of the air and, in so doing, avoids conflating “air” and “sponge” on the basis of their similar make-up. Nonetheless, he presumes that air and sponges share the same functional features: whatever the form of the “grains of air,” they can be penetrated by water just like a sponge.

Bachelard pursues his analysis with a couple of additional illustrations of a similar and even more explicit use of the image of the sponge by several “subaltern authors.” He creates interesting contrast by eventually arriving at Descartes, whom he sees as an example of a “very great mind [...] stuck, so to speak, in primary images.” It could be assumed, nevertheless, that his account should be here more nuanced. For even if it was accepted by all that Réaumur’s attempt to drift away from the common image of the sponge was only verbal (in fact we believe there are good reasons to be wary of this judgment), as Bachelard claims, we find the difference between his conscious effort to abandon the metaphor of the sponge and Descartes’s explicit keenness to accept it significant. It may be that both authors were “stuck” in primary images, but these primary images do not seem to be allowed to enter their science through the same channels. Descartes (but not Réaumur), as Bachelard reminds us, considered the image of the sponge perfectly clear and distinct, and as such suitable for scientific explanation:

Descartes’s confidence in the clarity of the image of the sponge is very symptomatic of this inability to bring doubt to bear on the detail of objective knowledge, to develop a discursive doubt that would wrench asunder all reality’s bonds and images’ every angle. General doubt is easier than particular doubt.

Let us add that Descartes is not the sole target of these critical words. The motif of the “detail” that “philosophers” neglect is to be found at the heart of Bachelard’s epistemological program in *The Philosophy of No*, published only two years after *The Formation of the Scientific Mind*. In this work, Bachelard condemns the “integral philosophy of the philosophers,” too monist and naïve in its prescrip-
tions, that needs to be completed by the “differential scientific philosophy” sensi-
tive to every epistemological detail. It suggests not only that every notion, hypoth-
thesis, problem, experience or equation (the list is Bachelard’s) needs to be studied,
but also—and more importantly—that every piece of any scientific construction
should be given the chance to present its particular philosophy. This epistemolo-
gist’s cautious stance, however, should not be confused with careless tolerance.
This is why Descartes’ credulous acceptance of the image of the sponge rightfully
earns him Bachelard’s criticism.

Credulously or not, Descartes and Réaumur share the image of the sponge, and
this very fact is sufficient for Bachelard to treat them on an equal footing. This
continuity, as it was suggested, merits to be challenged. Unlike Descartes, Réau-
mur actually failed to overcome the power of the image of the sponge despite the
fact that he was mistrusting its validity (Condillac is, in this respect, more lucid
than Bachelard is when criticizing Descartes for having doubted too generally).
In this respect, Réaumur’s situation appears to differ from that of Descartes: al-
though repudiated, in the end the image of the sponge is maintained by Réaumur,
since it is reconstituted, in the amended knowledge, in the seemingly desubstan-
tialised form of spongiosity. For the scientist, but also for the epistemologist, this
type of situation appears to be even more defying that the kind of full-on resis-
tance that only the future deplores.

Identification of the ancient knowledge reemerging, in the new science, trans-
figured, constitutes a serious challenge. In a slightly different context, Bachelard
discusses the same metaphor of the sponge in his “Lumière et substance” (1934),
a short paper on the history of photochemistry, that has been longtime obtruded
by the materialistic image of the light absorbed by the matter. The light combines
with matter and communicates to it its properties (some even claim it provides
a “substantial principle of colors”). The metaphor of the sponge proves to be
particularly tenacious as it shows ready to transform itself and to adapt, with the
metamorphosis of the “materialistic intuition” that supports it, to new condi-
tions:

Materialistic intuition can, moreover, return under another more or less
diverted form, under a more scientific aspect, leading one to imagine a
pure and simple conservation of force or vibration, as one imagined in the
eighteenth century a conservation of a specific fluid or substance.\textsuperscript{25}
The idea of absorption (associated to the sponge) thus re-emerges in a new form when, for instance, the coal is supposed (according to George Stephenson that Bachelard comments) to “conserve” the light it has received during the day and to give it back on fire. As long as the image of the absorption is invoked as an answer, and not as a problem, the rational science is suspended by the immediate realism. And the sponge seems to be, for Bachelard, its object-fetish.

THE PHILOSOPHY OF NO CHALLENGED

We have already conceded that examples of infiltration of ancient knowledge into new science, whether explicitly refuted or not, are rather rare in Bachelard’s book. And yet we have good reason to believe that this issue is by no means marginal in his mind. The next quotation comes from Bachelard’s foreword to The Formation:

Even in a clear mind there are dark areas, caverns still haunted by shades, and traces of the old remain in our new ways of thinking. The eighteenth century still lives secretly within us and may—alas—return. We do not see this as proving the permanence and fixity of human reason, as Meyerson thought, but rather as evidence of the somnolence of knowledge and the miserliness of cultivated minds that go over and over the same knowledge and culture and become, as all misers do, victims of the gold they so lovingly finger. We shall indeed show the improper endosmosis occurring when the assertoric is made to flow into the apodeictic and memory into reason.26

We find it also significant that Bachelard uses Plato’s allegory of the cave to prepare his readers to hear about non-scientific residues within scientific knowledge rather than about the mind’s inability to cross the border of positivity. All this should be seen as confirming the sincerity of the subtitle of The Formation which reads: A Contribution to a Psychoanalysis of Objective Knowledge, and provides the same message—it is the non-scientific within the scientific, more than non-scientific thinking preventing the advent of science, that preoccupies Bachelard.

The general exegesis of Bachelard’s book is nevertheless not my first interest. Instead, I wish to bring forward several suggestions concerning the possible developments of Bachelard’s observations. I find indeed the image of “improper endosmosis” occurring when “memory flows into reason”27 highly evocative as it invites to complete, and even amend, the manner how Bachelard is usually understood.
In fact, this formula brings us beyond the situation of science disrupted by common knowledge (Lecourt’s *ordinary thought*) and allows us to consider all cases in which, due to ordinary intuitions and natural tendencies of human mind, the new knowledge is insufficiently secured in the face of the undesirable vitality of what was brought into disrepute. Once the possibility that the new science’s “no” addressed at ancient science may be *challenged* accepted, several propositions can be formulated.

1. First, a piece of advice (a moral, if one prefers) for scientists; a plea for the kind of “epistemological vigilance” known to sociologists, however surprising this reference may sound. We take the term, of course, from *The Craft of Sociology*, an openly Bachelardian “handbook” by Pierre Bourdieu, Jean-Claude Chamboredon, and Jean-Claude Passeron. Largely preoccupied with the contamination of the sociologist’s work by “spontaneous sociology,” it links up very explicitly with Bachelard’s epistemology, which it applies and develops in order “to enable students of sociology to become better equipped to cope with the pitfalls of sociological research.”

An interesting tension, however, arises between this incentive to “epistemological vigilance,” as it is addressed to individual researchers, and Bourdieu, Chamboredon and Passeron’s critique of Bachelard’s psychologism. For in the view of these authors, it is a mistake to ascribe (epistemological) errors directly to knowing subjects. Errors are not to be directly imputed to persons; more likely they are functions of epistemological positions “that can only be fully understood in the social field in which they are put forward.” It may be answered, nonetheless, and however paradoxically may it sound, that to invite researchers to practice “epistemological vigilance” is not to deny, but on the contrary, to reaffirm the non-psychological theory of error. Proceeding from the conviction that the mind is never scientific in itself, the “vigilance” is supposed to rest not only on the “adequate knowledge of error” (inspired by Bachelardian epistemology) but also on the knowledge about “the mechanisms that can induce it” (informed by the sociology of knowledge).

*The Craft of Sociology* does adhere to the therapeutic tone of Bachelard’s psychoanalysis. After all, the sanative ambition of the book is announced—along with Bourdieu’s and his collaborators’ acerbic argumentative style—since its very first sentence:
In contrast to the tradition which draws the line at the logic of proof, refusing on principle to enter into the arcana of invention, thereby condemning itself to oscillate between a rhetoric of formal exposition and a literary psychology of discovery, we try here to provide the means of acquiring a mental disposition which is the precondition for both invention and proof.\textsuperscript{34}

However, epistemological vigilance as an acquired mental disposition does not combat the researcher’s own “idiocy.”\textsuperscript{35} Its inspiration is sociological: Instead of reforming scientist’s morale, it helps him to take better control of his epistemic operations.

2. Other suggestions may be of interest for philosophers of sciences. We believe indeed that Bachelard’s insights have not been fully expanded upon. One example where there is much room for following up on Bachelard is when studying the full trajectories of “officially” expired but still refractory knowledge. Lorraine Daston’s proposition to survey the “biographies of scientific objects” could be seen as an analogous invitation, given that scientific objects (objects of scientific inquiry), as she insists, not only come into being but also pass away:

Sometimes they are banished totally from the realm of the real, as in the case of unicorns, phlogiston, and the ether. More often, they slip back into the wan of reality of quotidian objects, which exist but do not thicken and quicken with inquiry.\textsuperscript{36}

Here the picture of slipping into the wan of reality of quotidian objects is very similar to the one evoked by Dominique Lecourt who, as we have seen, calls his readers’ attention to the type of epistemological obstacle that “demotes [scientific thought] to the rank of ordinary thought.” However, in light of our subsequent analysis, this fear of the ordinary may appear as based on too clear-cut distinctions. In fact, Bachelard’s detection of the improper endosmosis of memory into reason suggests that repulsed or otherwise abandoned scientific objects sometimes embark on more complex paths. An identification of this phenomenon not only allows us to presume that outmoded scientific objects are not always withdrawn from scientific practice as easily as scientists would like; it also suggests that their déclassement\textsuperscript{37} may take the form of a gradual retreat that is performed
inside the scientific enterprise. Within the special context of the history of chemistry, Michael Friedman, for instance, offers an excellent example of such a progressive retirement when identifying, among the models of molecules proposed at the end of the 19th century, “hybrids” that found themselves halfway between the fading use of paper (folded) models and the newly promoted iconic representations.

Epistemology not only appears to be technically well disposed to take over this research field, it may also find some help in its exploitation for its better understanding of the heterogeneous structure of science. It was said that the scientist should commit himself to “epistemological vigilance” in order to better resist the resurgence of the past; the epistemologist, for his part, should have the ambition of discerning its forms and functions.

3. The program of exploring trajectories of memory flowing into reason requires a more conciliatory attitude than the one Bachelard manifested towards this type of irregularity. For him, “endosmosis” was always “improper” (abusive), and therefore its condemnation prevailed over its positive observation. Significantly enough, Bachelard’s successor at the forefront of French-style historical epistemology, Georges Canguilhem, can be seen as someone who was inspired by the same indignation. While promoting a sharp distinction between science and scientific ideology, Canguilhem seems to uncompromisingly exclude the study of “repudiated knowledge” from the legitimate occupations of the epistemologist:

...the separation between ideology and science should prevent, in the history of science, the situation in which any element of ideology seemingly preserved would be placed in continuity with the scientific construction that has dismissed the ideology.

Even if Canguilhem’s concern is somehow different from that of Bachelard (it is above all related to good practice in the history of science, which should be wary of false and superficial resemblances), his refusal to deal with “scientific ideologies” potentially dissuades the epistemologist to follow officially dismissed knowledge during its process of retreat.

An objection could be raised here at this point. Isn’t it true that in his 1969 conference “What is Scientific Ideology?,” from which our quotation
comes, Canguilhem chooses a rather compliant attitude vis-à-vis scientific ideologies? “A history of sciences that deals with a science in its history, considered as a painstaking purification of the norms of verification, cannot ignore scientific ideologies.” Nevertheless, it is obvious that the purpose of this broadening of the scope of the historian’s investigations is not to study the history of scientific ideologies. It is significant that when Canguilhem wishes to give “a persuasive example of the process of destitution of a [scientific] ideology,” he takes no interest at all, in his analysis, in any kind of historical movement. Thus, when Canguilhem discusses the work of the French philosopher and naturalist P. L. Maupertuis, he does so exclusively in order to censure Maupertuis’s inclusion into the history of genetics, which in Canguilhem’s view was legitimately inaugurated only by G. Mendel. To conclude, if scientific ideology needs to be addressed by the historian of sciences, it is first and foremost to say he will be able to better orient himself within the “integral past,” which is en bloc not worthy of his consideration.

Canguilhem’s treatment of Herbert Spencer’s evolutionism brings an additional and even more eloquent confirmation to our analysis. For Canguilhem, Spencer is an imposter: in fact, his “organicism” conceals just a weak relationship between the biological theories of his time, to which he regularly refers, and his own speculations, which are foremost politically motivated. In this case, the process of the destitution of scientific ideology is well evoked by Canguilhem, although very significantly, it is in the end handed over to sociology: scientific ideologies disappear when “historical conditions of possibility change.” As was said above, we have good reasons to think that this transformation of the (epistemological) question of “how” into the question of “why” is far from being an accident.

Is epistemology in its traditional form inhibited by the over-valorization of validity that abusively informs its object? It is not our ambition to develop the question further at this time. After these short reflections inspired by Bachelard and Canguilhem, we simply wish to suggest that the value and the function of a “past” that slips in the “present,” a process that Bachelard views negatively, perhaps merits more and closer study in an empirical fashion.
CONCLUSION: HISTORICAL EPISTEMOLOGY SYMMETRIZED

“What would happen if the humble workers of the proof, still and always reactive through the nature of trials and proofs, suddenly discovered the truth, unbelievable and bare: that the intimate motivation to explore, that the key to discovery, that the possible unveiling of true intuition, dwell neither in the competition nor in the desire to dominate, but in the rejoicing?” This is how Michel Serres concludes his review, already cited, of Bachelard’s *The Formation of the Scientific Mind*, which he attacks for its therapeutical and moralizing character, but also—and here Serres aims at the very heart of Bachelard’s *philosophy of no*—for the assent it gives to the “malevolence” that dwells “in the root of the knowledge” of occidental man: “To know is to hunt, conquer, violate, empower, destroy. [...] Knowledge is against: against nature, against its own understanding, against itself and against the past, against others, one by one and all together.” The “rejoicing hypothesis” that Serres suggests as an alternative sounds, nonetheless, like something that adds more psychology to epistemology, which on the contrary needs to be lightened in this respect. Surprisingly enough, as Bachelard shows, it is the category of *validity* that sometimes appears to be overly psychologized. By the same token the efficiency of the “violence” with which science discredits and expels the non-scientific from its heart shows weakened.

Whether science progresses by refutations or whether its growth is powered by some kind of joyful energy is eventually an empirical question. In the same way, an empirical inspection is needed in order to learn more about the (potentially typical) trajectories of all these “epistemological details” that, even though acknowledged as invalid, continue to inform the science growing on their grave. Bachelard’s survey of “epistemological obstacles” as offered in his *The Formation of the Scientific Mind* can be interpreted as showing what the first steps on this path might look like. This is, at least, what I found in Bachelard’s analysis of Geoffroy’s and Reaumur’s thought, supported by illustrations of “epistemological obstacles” understood as causing abusive intrusions of pre-scientific knowledge into new science. Under a generalized form of *memory’s endosmosis into reason*, it was then suggested that epistemology could profit from disregarding the offence to reason thus caused when preparing better conditions for a thorough study of the relics of the past.

In the final analysis, it is perhaps Bachelard’s commitment to the value of scientific progress that caused him to be somewhat insensitive to the field of research.
that we propose to explore systematically. It is my suggestion that accepting this new object of inquiry—the posthumous life of the discarded science—would not only allow to broaden epistemology’s range of action, but above all it could help epistemology to definitively shift its focus from the triumphant to the living science, and consequently strengthen its status.
NOTES

1. I would like to thank the two anonymous reviewers for their insightful comments on the first version of this paper and their stimulating suggestions.


8. “Psychoanalysing realists” is the title of the chapter VII, 136–153.


12. “Exiling gold! How can it be said, calmly and collectedly, that gold does not bring health, that gold does not give courage, that it does not stem the flow of blood nor dispel the phantoms of the night, the burdensome memories arising from the past and from our errors, that gold is not the ambivalent wealth protecting both heart and soul? For this, real intellectual heroism is required, and an unconscious that has been psychoanalysed, that is to say a scientific culture completely removed from any unconscious valorization. The pre-scientific mind of the eighteenth century has not achieved this freedom to judge.” (Bachelard, *The Formation*, 141-142)

13. “Realism” gains a specific meaning in this discussion. It combines “substantialist convictions” with a “miser’s joy” of possessing the riches of the reality that has to be jealously guarded. This is how the preciosity of precious stones undergoes a “mutation of values” and reappears in their healing power. See Bachelard, *The Formation*, 136-137.


16. Bachelard, *The Formation*, 138. Notice that Bachelard doesn’t speak about the hardness or the resistance of old beliefs; he chooses instead the medical term “induration” in order to indicate that what he has in mind is a reaction to the critical re-examination of ancient beliefs.


21. Bachelard discusses the metaphor of the sponge in the fourth chapter of *The Formation* as a representative illustration of “verbal obstacles” to scientific mind to which the chapter is dedicated. Although he speaks, in the very first paragraph of this chapter, about “purely verbal habits” that hinder scientific thought, Réaumur’s case seems to prove that it would be a mistake to charge the word itself with full responsibility for postponing the entering into scientificity. According to Bachelard, Réaumur’s dropping of the word “sponge” is “simply and solely a linguistic movement” (Bachelard, *The Formation,* 83), i.e. nothing more than a linguistic movement. Erasing the word doesn’t therefore constitute a notable step forward. I tend to disagree with this judgment. Even if the disappearance of a word cannot here count for an “epistemological act” as Bachelard understands it (as an unexpected impulsion intervening in the scientific development, see Gaston Bachelard, *L’activité rationaliste de la physique contemporaine.* Paris: Presses universitaires de France, 1951, 25), it is likely to produce what we suggest to call an “epistemological event,” given that some important part of the control on the image structuring the thought is lost.


23. For Bachelard’s use of the term “scientific philosophy” compared to that of the Vienna School, see Sandra Pravica, “‘Scientific Philosophies’ in the early 1930s and Gaston Bachelard on ‘induction’,” *Epistemology and History from Bachelard and Canguilhem to Today’s History of Science* (preprint), Max Planck Institute for the History of Science, 2012, 159–169, available at: https://www.mpiwg-berlin.mpg.de/Preprints/P434.PDF


28. Here I follow Dominique Lecourt who calls our attention to the figure of Nature that Bachelard put forward. With regard to *The Formation of scientific mind,* Lecourt remarks: “Apparently, Bachelard does not care, here, about the effective history of the sciences in the 18th century. What is given to us to decipher in these texts [studied by Bachelard], it is the mythical figure of a ‘natural state’ of the scientific mind: quite at the same time native and trans-historic state where can be read, in a straightforward manner, the essence of a mechanism, today veiled by its own manifestation.” (Dominique Lecourt, *Bachelard. Le jour et la nuit.* Paris: Bernard Grasset, 1974, 127-128)

29. Pierre Bourdieu, Jean-Claude Chambredon, Jean-Claude Passeron, *The Craft of Sociology: Epistemological Preliminaries.* Trans. Richard Nice. Berlin—New York: Walter de Gruyter 1991. The book, which was originally published in 1968, represents an astonishing attempt to apply Bachelard’s epistemology to social sciences. Bourdieu, Chambredon and Passeron do not deny that such an undertaking may cause some difficulties, but they are convinced that these are to be studied instead of nourishing “artificial distinctions” between natural and social sciences.

30. Bourdieu, Chambredon, Passeron, *The Craft of Sociology,* v. Yves Gingras notes that Bachelard himself speaks, in a similar context, about an “intellectual watch on oneself” (surveillance
“Errors” are here to be understood as misconducts in relation to the true scientificity.

Bourdieu, Chamboredon, Passeron, *The Craft of Sociology*, 3. In fact, Bachelard is not completely ignorant of that. Consider his commentary on Geoffroy: “Exiling gold! How can it be said, calmly and collectedly, that gold does not bring health, that gold does not give courage, that it does not stem the flow of blood nor dispel the phantoms of the night, the burdensome memories arising from the past and from our errors, that gold is not the ambivalent wealth protecting both heart and soul? For this, real intellectual heroism is required, and an unconscious that has been psychoanalysed, that is to say a scientific culture completely removed from any unconscious valorisation. The pre-scientific mind of the eighteenth century has not achieved this freedom to judge.” (Bachelard, *The Formation*, 141–142).

37. The term is used by Dominique Lecourt in the text quoted above, where the original verb “déclasser” is translated by “to demote.”
41. Canguilhem, “Qu’est-ce que l’idéologie scientifique ?,” 44–45.
42. Canguilhem, “Qu’est-ce que l’idéologie scientifique ?,” 40.
43. Canguilhem, “Qu’est-ce que l’idéologie scientifique ?,” 43.
**INTRODUCTION**

In this paper, I will explore the relation between science as a rational project and scientific research as a human practice. On the one hand, science can be understood as a project manifesting a rationality that transcends the situatedness of human practices. On the other hand, however, science seems to be a fundamental human activity as it is in scientific practices that scientific objects and facts come into being. The French philosopher Gaston Bachelard was among the first to specifically address the relation between the rational and the practical aspects of science, without prioritizing either of the two.

“Without pretending in any way to be laying the foundations of modern physics, I hope to suggest how common philosophical positions must be modified to accommodate reality as it is revealed in the scientific laboratory.”
—Gaston Bachelard, *The New Scientific Spirit*
Based on developments in 20th century physics, Bachelard maintains that science is best understood as a collective activity taking place in local scientific practices, and he emphasized that the objects of the sciences exist only insofar they can be realized in what Bachelard calls phenomenotechnique.1 This concept denotes Bachelard’s insights that the objects of physics are not to be found in an external nature, but are artificially realized in scientific experiments and the technologies used in those experiments. When extending to contemporary scientific practices in general, we can no longer understand the different sciences as being concerned with the *discovery* of their objects, but instead with the *construction* of them. Accordingly, the way in which scientific objects are created within scientific practices is the central focus of Bachelard’s epistemology.2

Nowadays, the idea that scientific objects are constructed in situated practices, and are therefore for a large part dependent on human interventions, figures prominently in (continental) philosophy and anthropology of science. For example, it forms the core of the early work of the French philosopher-anthropologist Bruno Latour, who is interested in studying practices of science-in-the-making, as opposed to focusing on the finished theories and facts of “ready-made science.”3 In showing that the objects of the sciences are actively constructed by groups of scientists, Latour challenges the idea that science is a rational project able to attain universal truths about an external world.4 In this context, Latour and Woolgar approvingly, yet mistakenly as I hope to show in this paper, refer to Bachelard’s concept of phenomenotechnique:

> The artificial reality, which participants describe in terms of an objective entity, has *in fact* been constructed by the use of inscription devices. Such a reality, which Bachelard (1953) terms the “phenomenotechnique,” takes on the appearance of a phenomenon by virtue of its construction through material techniques.5

In this quote, Latour and Woolgar contrast objectivity with construction. This contrast implies that while the researchers in the laboratory act *as if* they are speaking about an entity that is objectively out there, *in fact* they are speaking about something that is constructed and does not exist outside of the structure of the laboratory. Hence, while Latour stresses that scientific objects are situated constructions realized in scientific practice, he does not explicitly address the question whether there are specific characteristics to their process of production that justify the adjective ‘rational,’ which was a central question in Bach-
elard’s epistemology. As a consequence, his analyses of scientific practices tend to emphasize the practical character of knowledge production, but often fail to appreciate the rational criterion that warrants the specific practical actions. This brief discussion allows to formulate the question I address in this paper more precisely: How are the ‘rational’ and the ‘practical’ integrated in scientific practices? Bachelard was similarly concerned with this question when distinguishing between the practice of the science and the project of science. His work has not received much attention in recent philosophical analyses of scientific practice.6

In this paper, I propose to use Bachelard’s epistemology as an entry-point to the question how ‘scientific’ and ‘practice’ are interrelated such that something as ‘scientific practice’ is constituted.

The paper is structured as follows: Firstly, I show why, according to Bachelard, science can only be realized through an epistemological rupture with our ordinary experience (1). Secondly, I will show how this break is realized in scientific practice by introducing Bachelard’s notion ‘phenomenotechnique’ (2). Thirdly, I discuss why Bachelard holds that a scientific rationality remains to be assumed within phenomenotechnical constructions, and why he holds that scientific objects are not only technical, but also rational realizations (3). Fourthly, I use Bachelard’s epistemology to show how the scientific object ‘cognition’ is realized within the cognitive neurosciences (4). To conclude, I offer some thoughts of how Bachelard’s epistemology can be of ongoing relevance by showing how it allows to evaluate the socio-material environment in which science takes place in terms of the interrelation of the practical and the rational within the phenomenotechnique (5).

1. SCIENCE AND THE EPISTEMOLOGICAL RUPTURE

One of the central aspects of Bachelard’s philosophy of science is his notion of epistemological rupture, which stresses that there is—and should be—a fundamental divide between scientific experience and ordinary experience. Science should overcome the “obstacles that everyday life has set up.”7 Bachelard juxtaposes the world of everyday life with the world of science, and argues that science should break with our initial experience in order to realize its rational potential. In fact, he holds that science “must be formed against nature, against all that comes from nature’s impetus and instruction, within us and outside us, against natural allurements and colourful, diverse facts.”8 Only when successfully suppressing human primary impulses, it becomes possible to enter the domain of
science that aims for the development of theoretical knowledge.

According to Bachelard, our initial contact with the world is—contrary to the rationalist purpose of science—grounded in our primary drives that induce reverie and dream. Primitive encounters with objects induce reveries that create images transcending the objects that we encounter. This act of transcending takes place through our primitive drives, and precedes any kind of reflection: “We are being faithful to a primitive human feeling, to an elemental organic reality, a fundamental oneiric temperament.” This oneiric aspect of our primary experience is characteristic of the way the reality of everyday life is constituted. Only when overcoming this oneiric state, a rational stance towards the world can come into being. Rationality is a continuous process of overcoming primary impulses: “In point of fact I see no solid basis for a natural, direct, elemental rationality [...] Rationalist? That is what we are trying to become.”

The second reason for the need for an epistemological rupture between science and everyday life is illustrated in The Philosophy of No in the context of developing a scientific understanding of heat: “Between sensory knowledge and scientific knowledge there is a gap. Temperature is seen on a thermometer, one does not feel it. Without theory, one would never know whether what is seen and what one feels correspond to the same phenomenon.” We need theory in order to connect the different ways in which temperature can become present to us. Without theory, so Bachelard holds, it is not rationally warranted to infer that the numerical presentation of heat on a thermometer is related to the heat of the sun that we feel on our skin. Only when appreciating the complexity of temperature requires, and breaking with our everyday experiences, it can be understood that the concept of heat is complex, and to investigate how the different aspects of heat are integrated.

Bachelard explicitly terms his philosophy of knowledge a non-Cartesian epistemology. His non-Cartesianism is most clearly visible in his criticism on Descartes’s wax argument. In the Second Meditation, Descartes argues that wax cannot be clear and distinctly perceived by the senses because its form changes when heated, “for whatever came under the senses of taste, smell, sight, touch or hearing has now changed; and yet the wax remains.” This is why he concludes that the idea of wax is not grasped by the senses, but is understood by the mind alone. Bachelard, however, argues that precisely the diverse manifestations of the wax under different circumstances are the basis of scientific research because these complicate
our initial experience. When revealing complexity it becomes possible to connect the different complex elements of wax. At the same time, revealing this complexity works against our natural inclination to think of wax as a singular object in our ordinary experience. While Descartes concludes that certainty is founded in a *simplicity* existing in the mind alone, Bachelard holds, on the contrary, that scientific certainty should be found in the *complexity* of the shape of the wax under different experimental circumstances.

In Bachelard’s view, when asking for the possibility of scientific certainty, we should not start from the individual mind of the philosopher, but turn to how processes of objectification actually take place within the sciences. When looking at scientific practice, it becomes clear that the scientific objects never exist in the mind alone, but always have a twofold relation with the empirical results of scientific experiments. Firstly, the objects of science are complex objects in the sense that they are connections of different observed phenomena. Secondly, it is in relation with this increasing complexity that science is able to overcome the subjective aspects of ordinary experience, and strive for objectification. Only in this way can we understand the continuous development of the sciences: “subjective [Cartesian] meditation is bent on attaining clear and definitive knowledge; objective meditation differs from this by the very fact that it makes progress, by its intrinsic need always to go further, to extend the limits of the known.”

The objective meditation of the laboratory scientist realizes an epistemological rupture with how nature is ordinarily encountered. While Descartes concludes that the changing qualities of the wax force us to dismiss the trustworthiness of sensory experience, Bachelard holds, on the contrary, that it is precisely the experimental revealing of the diverse manifestations of the wax that allows for its objectification. Scientists must continuously be open to experience new objects, which are constituted by how different aspects of them are experimentally revealed. The objective meditation strives to continuously expand the limits of the known through the rational integration of experimental diversity. The extent to which such an objective mediation of the complexity of scientific objects indeed requires, as Bachelard would have it, an absolute rupture with ordinary experience remains up for discussion. However, Bachelard’s understanding of the rationality of science in terms of an epistemological rupture opens up the possibility to make clear that scientists in practice construct scientific objects that cannot be reduced to the sensory experiences of scientists. Rather, as is expressed in Bachelard’s notion of phenomenotechnique, the realization of scientific objects is
one of rationally integrating a diversity of complex phenomena into objects that explain this diversity.

2. PHENOMENOTECHNIQUE

The start of the 20th century was marked by great developments in physics. It saw the birth of relativity theory and quantum mechanics, and broke with earlier theories in physics that were grounded in classical mechanics. According to Bachelard, this break did not just have scientific consequences, but also forced philosophy to “modify its language if it is to reflect the subtlety and movement of contemporary thought.”16 Philosophy should follow the course of these most recent scientific developments, because “science in effect creates philosophy.”17

One of Bachelard’s key epistemological insights is that the objects of 20th century physics cannot be cut loose from the technologies used to observe them. For example, the phenomena observed in the scientific experiments such as electrons, are constructed within scientific experiments, and do not exist independent of the technologies through which they are realized.18 This is why Bachelard argues that we should understand the objects as constituted within a phenomenotechnique, because “it is then that we understand that science realizes its objects without ever just finding them ready-made. Phenomenotechnique extends phenomenology. A concept becomes scientific in so far as it becomes a technique, in so far as it is accompanied by a technique that realizes.”19 If epistemology and philosophy of science are indeed to be grounded in the development of science, it should be acknowledged that scientific objects cannot be cut loose from technology, because (i) these are the product of a technical mode of action, and (ii) their existence is instantiated by technologies used in scientific experiments.

According to Bachelard, “when we have followed contemporary physics, we have departed nature to enter in a factory of phenomena.”20 Scientific practices are dependent on the uniform working of scientific technologies, which are interpreted as reified theorems that “provide a certitude which is lacking in more passive knowledge.”21 In this sense, science resembles industrial technology because both depend on the stabilization of their objects. Technologies provide the basis for the construction of scientific phenomena that remain stable in different experimental contexts in a similar way that their use in mass production creates a stability among a set of products. However, we should not conceive of this analogy as a way to diminish the distinction between scientific practices and the practices
of mass production in industrial factories. While the maintenance of stability is a sufficient condition for pursuing the ends of technological thinking, this stability must be transcended in scientific practice.

The transcending of the stability of the given phenomenon is what Bachelard describes as the “unanticipated paradox, which shows knowledge to be fleeting and mobile, and the action, which it brings to light to be solid and assured.”\textsuperscript{22} Although science relies on stable technical actions, attaining knowledge is a matter of moving beyond what is technically created. According to Bachelard, the crucial difference between science and industrial technology must be located in the fact that the end of a technological process for industrial means is part of the way it is realized, while this goal-directedness is absent in science. For example, the working of a water wheel generating electricity can be exhaustively explained in terms of the empirically observable functional mechanism through which a particular amount of electricity is realized. The observation of an electron in a scientific experiment, on the contrary, assumes prior mathematical assumptions that are not part of its realization, but are required to integrate a complex set of observable effects can be integrated into the singular object ‘electron.’

Industrial technology deals with closed systems that can be characterized in terms of their finality. The knowledge that is needed of the exact workings of this system is relative to what it intends to achieve: technology aims for an approximate knowledge relative to goals already set.\textsuperscript{23} On the contrary, science cannot be limited to the schemes in which technological systems work in everyday situations. Scientific experimenting and theorizing are part of an open process of knowledge development that cannot be described in terms of the ends they serve. Accordingly, the phenomenotechnique that constitutes scientific practice must not be equated with a particular technical mode of action that realizes its goals by employing scientific technologies.

Reminiscent of Descartes, Bachelard distinguishes between knowledge and action.\textsuperscript{24} Industrial technologies are concerned with the domain of everyday life action, while the phenomenotechnique constructs objects about which scientific knowledge can be obtained. The difference between the two becomes clearly visible when contrasting scientific experiments with the technological realization of a certain goal within a closed system. In industrial systems, technological processes are used to continuously make the same product: any unexpected results would be considered failures. In mass industry, the goal is to create a large set
of indistinguishable products, and the coming into existence of each individual product can be defined in terms of the actions through which they are created. The objects of science are not the product of a goal-oriented endeavor. Scientific experiments are based on existing hypotheses that structure how an experimental set-up is build, but they are supposed to generate something new by increasing the complexity of the object under study. This is why experiments do more than just testing a hypothesis, because in the confrontation between hypothesis and empirical manifestation, new scientific objects may be realized. In contrast with technology, science is an ongoing open process of hypothesizing and correcting previous knowledge that is contradicted in scientific experiments.

3. THE RATIONALITY OF SCIENCE AND THE PHENOMENOTECHNIQUE

Bachelard interprets the history of epistemology as an ongoing debate between rationalists and realists. He opposes the idea that certain knowledge, i.e. scientific knowledge, must be understood either in realistic terms (knowledge successfully reflects the structure of an external reality) or in rationalistic terms (knowledge is the product of the human mind). According to Bachelard, both of these positions fail to do justice to how science actually works. They are “the results of impermissible abstractions that did not do justice to the complexity of the contemporary sciences.” When looking at scientific practice, Bachelard notes that those two positions do not conflict, but “coexist peacefully in the modern scientific mind.” Science is as significantly the product of the rational activity of the scientific mind, as it depends on the material manifestation of phenomena in scientific experiments. Accordingly, a philosophy of science should reflect both of these aspects.

According to Bachelard, the new sciences of the early 20th century break with earlier philosophical theories of knowledge in two ways: (i) New science is based on the co-existence of rationalism and realism, and cannot be reduced to either of the two, and (ii) the objects that new sciences speak about are not ‘discovered’ in ‘nature,’ but are constructions that are phenomenotechnically realized in scientific practices. Consequently, a philosophy of science should aim to come to a synthesis of rationalism and realism that takes into account the constructed nature of scientific objects. Bachelard uses the terms ‘applied rationalism’ or ‘technical materialism’ to refer to the position that adequately reflects this middle position between rationalism and realism. These terms illustrate that a philosophy of science should always oscillate between the rationality of science itself, which cre-
ates a domain of inquiry that breaks with ordinary experience, and the constructed nature of scientific objects that are the product of technological manipulations on a rationally plain.\textsuperscript{28} No priority should be assigned to either the rationality of mathematics or the way scientific objects become empirically accessible within the phenomenotechnique. The material environment in which scientific phenomena become visible helps realizing scientific objects, but it is only because these can be meaningfully interpreted against an already existing mathematical background that these phenomena become significant. The objects of science appear in an environment that is “mathematically meaningful before it is phenomenally significant.”\textsuperscript{29}

Bachelard develops his philosophical position by answering the question: ‘How are the objects of science made?’ Or in Bachelard’s words: “Tell me how you are sought and I will tell you what you are.”\textsuperscript{30} As we saw, in Bachelard’s view, science is realized by establishing an epistemological rupture with ordinary experience. Accordingly, the phenomena encountered within the phenomenotechnique should not be related to as objects of ordinary experience. Loosely following the Kantian distinction between phenomenon and noumenon, Bachelard holds that strictly speaking, scientific objects are not grounded in sensory experience, but are the products of mathematical thinking. However, the twist that Bachelard gives to the Kantian distinction conflicts with Kant’s conception of the noumenon. While the noumenon is by definition inaccessible in Kant’s view, Bachelard holds that the fact that some scientific phenomena can never be perceived does not prevent scientists from having epistemological access to them.\textsuperscript{31} Bachelard locates the rationality of scientific practice in the creation of a noumenal plain in which scientific objects appear. Contrary to the Kantian noumenon, Bachelard’s noumenon is scientifically constructed and knowable by the human being.

In 20\textsuperscript{th} century microphysics, Bachelard holds, mathematics is a technique through which a noumenon is created in which scientific objects are made accessible. This mathematical grounding distinguishes scientific practices from ordinary practices in which technologies are involved. This does of course not imply that technological systems do not involve mathematical reasoning. For example, the product output of an industrial factory may well be mathematically predicted in terms of the amount of products the machinery is likely to manufacture in a certain amount of time. However, in contrast with scientific practices, the existence of the product (say, a shoe) is not dependent on this mathematical prediction. That is, contrary to scientific phenomena, the presence of mathematics is not constitu-
tive of the existence of technical products.

However, the sciences should not be reduced to their mathematical character. On the one hand, Bachelard argues that the sciences should rationalize reality in order to construct scientific phenomena against nature. On the other hand however, the reality of rationalizations is shaped in the way they become empirically accessible. This empirical realization of rational thought is, according to Bachelard, constitutive of the experimental character of 20th century science. This duality is reflected in the phenomenotechnique of scientific practice: the structure of the phenomenotechnique always works on the basis that a mathematical surface is rationally present, and can only realize scientific phenomena within this surface. This is why, in Bachelard’s view, technologies are both reified theorems and provide phenomenal stability across experiments because they perform homogeneous actions. The phenomenotechnique both contains the mathematical technique of creating a noumenal plain, and technologies that allow for the stable appearance of scientific phenomena across experiments.

Science takes place through “the application of the rational technique of scientific thinking [that] determines a genuine recurrence of rationality.” This can only be realized through the apodictic acceptance of rational values: it requires what Bachelard calls a rational apodicticity. Rational apodicticity makes it possible to break with ordinary experience and engage in a relation with the complexity of the phenomena realized through the phenomenotechnique. Thus, the apodicticity of rationality organizes the experience of scientists and enables them to recognize phenomena not as referring to natural objects but as complex relations out of which the rational objects of science can be constructed. Hence, phenomenotechnique is the recurring rationalization of a rationality that is already established, but must be continuously enacted in order to remain present as a prerequisite for the recurrence of scientific thinking. This is why science is never just mathematical: The objects of science are not merely realized through the rationality of the scientific mind, but are also constituted through their empirical realization within phenomenotechnique.

Bachelard’s view that philosophy should be guided by the development of science coincides with his acceptance of these developments as a standard of rationality. As was already hinted at in Bachelard’s reply to the Descartes’s wax experiment, it is only in comparison with contemporary scientific practices that earlier types of inquiry can appear as irrational, i.e. as not having been able to break with ordi-
nary experience. Bachelard does not refer to any standards of rationality that are external to the actual development of science. Only by looking at contemporary scientific practices can philosophers discover the workings of rationality.

Bachelard holds that science always develops in relation to previous scientific discoveries, and therefore partly involves the incorrect scientific judgments of the past. Furthermore, he holds that scientists can never fully overcome the epistemological obstacles, i.e. they can never fully break with ordinary experience. Science always develops against previous scientific discoveries; it stands always in a dialectical character with its own past. For Bachelard, this means that earlier epistemological obstacles and scientific errors remain a part of present research. It is only in relation with earlier scientific theories and scientific objects that new objects can emerge that can be theorized about, and new standards of rationality can come into being. Accordingly, Bachelard characterizes science as a dynamic process both guided and striving for rationality.

If science requires scientists to engage in a rational apodicticity, the question arises how this apodicticity is realized in scientific practices, and how it subsequently structures how scientific objects come into being. According to Bachelard, it is not the technique of creation that singles out the scientific character of the phenomenotechnique. Whereas the technique of creation brings objects within the field of the human senses, science should “amplify what is revealed beyond appearance,” which is for example illustrated in his remarks on temperature discussed earlier. The mere perceptual experience of a (constructed) phenomenon does not warrant its scientific character, but assumes a prior engagement in the rationality of the scientific project.

While Bachelard’s epistemology mostly focuses on (micro-)physics and chemistry, he considers all scientific specializations to be rational insofar they participate in the rationalist project of science at large, i.e., they presuppose a rational apodicticity. Yet, when arguing that science has regional rationalisms that belong to the particular sciences, he suggests that the process of constructing scientific objects may differ greatly across the different sciences. However, Bachelard holds that while each scientific practice is different, they are similar to the extent that they are scientific. While they differ in their specific practical make-up, they all are equally concerned with the rationalization of the real. That is, the structure of the particular phenomenotechnique at work within a particular scientific context can only function because it participates in a scientific rationality.
How must we understand the relation between the micro-aspects of practices across the different sciences, and the general rationality of the scientific project? In Bachelard’s view, science, as a project, is a manifestation of rationality. Science takes place in a ‘scientific city,’ and the inhabitants of this city should aim to come to a collective understanding of scientific objects through participating in the rationality of science. In Bachelard’s view, rationality emerges out of the social exchanges between scientists. Only within collectives is it possible that individual scientists do not obey their instinctual desires and drives characteristic of an ordinary experience of nature, and are classified by Bachelard as epistemological obstacles that should be overcome.38

Also this idea of the scientific city is grounded in how Bachelard conceives of the actual structure of scientific practice. When discussing that most of the papers appearing in scientific journals are written by several authors, he stresses that this cooperative aspect is typical for the way rationality is manifested in new science, i.e., in 20th century physics.39 This collective rationality functions as a model for how science should be organized, and how scientists are capable of communicating among each other in a rational manner. The idea that rationality can only be obtained when participating in actual scientific practice, and by relating to other scientists is most dramatically expressed in Bachelard’s latest fragments on poetics that were posthumously edited and published. In the *Fragments of a Poetics of Fire*, he writes:

I am of the conviction that an active rationalism must be associated with scientific labor, transforming all knowledge into scientific knowledge. Thus, if I were to write a new book as a rationalist, I would have to go to the school of one of the contemporary sciences. One can no longer be rationalist by oneself, on the fringe of contemporary scientific activity. It is necessary to learn together with the workers of rationality.40

The lonely individual is unable to produce rational knowledge, because rationality is constituted in the scientific city through the discursive practices between scientists. Only in this environment can the human mind engage in a rational apodicticity. The individual, on the contrary, is only capable of producing desires and dreams that are private by definition, and can only be expressed in poetry. Hence, a specific social structure is a necessary precondition for engaging in the scientific project. This collective rationality is not limited to personal interactions between scientists, but also structures how scientists relate to the phenomena they study.
In the scientific city, rationality is expressed in the books that are written about scientific phenomena. This collective discursive layer of the written word provides an extra foundation of the sciences, which adds to the noumenal construction of the scientific plain through mathematical techniques. Polemically, Bachelard refers to this discursive structure as providing a *bibliomenon* that helps providing a stability for the existence of scientific phenomena within the scientific community.⁴¹ Through the constant interaction with the scientific phenomena that exist within the bibliomenon, scientists remain constantly aware that the objects that science is about are not natural objects, but are artificially created. The collectivity of the bibliomenon is especially important for Bachelard, because the irrationality of the our ordinary experience remains constantly present in each scientist.

According to Bachelard, this collective and discursive structure of the scientific city guides how science is practiced on a micro-level. The micro-experience of scientific practice participates in the scientific project that guides scientific thinking. He conceptualizes this scientific project in terms of a rationality that continuously aims to correct previous errors. No matter what technologies, research objects, and concepts are present, the different sciences can all be considered scientific insofar they participate in the rationalist project of science at large. The structure of the particular phenomenotechnique at work within a particular scientific context can only function because it participates in a scientific rationality. Consequently, the micro-activity of scientific practice can only be performed to the extent that they are part of the macro-aspect of science as a rational project.

Scientific objects that are constructed within in a phenomenotechnique can only be appreciated within a structure that supports the possibility of engaging in a rational apodicticity. This structure is realized in the construction of a rational environment in which scientists are capable of continuously overcoming epistemological obstacles in their interactions with each other in the scientific city in which scientific phenomena are stabilized. Only in such an environment can the human mind by rectified such that it overcomes epistemological obstacles. The structure of the scientific city should therefore embody the rationality that is realized within the phenomenotechnique: the rationality present in the way scientific objects are realized in scientific practice should therefore be incorporated in the socio-material environment in which science takes place.
4. PHENOMENOTECHNIQUE AND COGNITIVE NEUROSCIENCE

Let me try to make clear the ongoing relevance of Bachelard’s epistemology by discussing a recent development in the cognitive neurosciences, thereby indicating that the notion of phenomenotechnique is not limited to microphysics, but can also be productively extended to other contemporary scientific practices. In the course of the history of the neurosciences, cognitive functions such as ‘attention,’ ‘empathy,’ and ‘agency,’ have been made available for investigation. Researching these specific cognitive functions requires the presence of specific technologies such as functional Magnetic Resonance Imaging ((f)MRI) or Electroencephalography (EEG), and the active construction of experimental set-ups in which they could be made present. These developments gave rise to specialized discipline of cognitive neuroscience. During experiments in the cognitive neurosciences also participants have an active role because they have to perform certain tasks that are thought to be potential measures of a specific cognitive function. Only within such experiments can brain states be linked to existing conceptualizations of human behavior. In other words, it requires the presence of a phenomenotechnique to realize these cognitive functions as scientific objects.

Mathematics plays a formative role within the phenomenotechnique. The brain activity displayed on (f)MRI scans are generated by comparing activity in different regions of the brain, a statistical task heavily dependent on computing power considering that fMRI divides the brain into approximately 138,000 voxels that are compared with one another. Scientists cannot execute such a mathematical analysis independent of a computer, which introduces an opaqueness into the way brain scans are generated. In fact, there is no possibility for neuroscientists to retrace the mathematical processes through which brain scans are generated step by step. Besides linking experimental outcomes to existing psychological concepts to explain human behavior, neuroscientists also have to evaluate how such are concepts are mathematically realized within the phenomenotechnique.

Let me try to make clear with an example how this problem is solved in the neurosciences when considering that scientific objects are the interplay between the phenomenotechnique and a rational apodicticity. In 2012, Craig Bennett and colleagues won the Ig Nobel Prize in neuroscience with a study that showed brain activity in a dead salmon using fMRI. The task that the salmon had to perform is described as follows by Bennett and colleagues:
The task administered to the salmon involved completing an open-ended mentalizing task. The salmon was shown a series of photographs depicting human individuals in social situations with a specified emotional valence, either socially inclusive or socially exclusive. The salmon was asked to determine which emotion the individual in the photo must have been experiencing.44

The point of this experiment is not to detect brain activity in a dead salmon, but to reveal the flaws occurring in statistical analyses in the cognitive neurosciences that did not correct for the so-called multiple comparisons problem. This problem states that, when a large amount of statistical comparisons are made, there is a significant chance that the test will yield some random results because of noise fluctuations. These random results are called false positives. Bennett et al. aimed to show that without employing statistical techniques correcting for this problem, several areas of the dead salmon’s brain were significantly active during the task. This result was visualized in a brain scan that contained red dots representing the brain activity in the significantly active regions: a result that would be an absurdity.

At this point, two things could be inferred: either the dead salmon was indeed cognitively active during the task, or the significant results were artifacts that could be explained by the multiple comparisons problem. Normally, when using living subjects in psychological experiments, the existence of artifacts can be explained by the experimental subject’s head movements or technological failures, but Bennett et al. aim to show that also an improper statistical analysis can generate artifacts. When reminding that fMRI compares approximately 138,000 voxels, the likelihood of false positives is extremely high in research in the cognitive neurosciences that uses fMRI. When no statistical analysis correcting for this problem is applied, brain scans thus falsely display red dots that indicate brain activity. Only when interpreters of brain scans are aware that they are confronted with phenomenotechnical realizations, it becomes possible to establish a critical relation with the practice and results of cognitive neuroscience. That is, only in this way can it be understood why the outcome of an object that is the product of mathematical relations can be mistakenly be taken to show brain activity in a dead salmon.

In the above example, revealing how scientific objects are the product of phenomenotechnical construction allows to reveal which existing scientific princi-
amples (such as the application of proper statistical analysis) need to be in place in order for a practice to function as a scientific practice. At the same time, what are the existing scientific principles—e.g., what is considered to be a proper statistical analysis—is itself dynamically constituted in the relation with the objects that are realized through the phenomenotechnique. The awareness of and reflection on these principles coincides with engaging in a rational apodicticity that allows for establishing a relation with the noumenal plain in which the objects of a scientific discipline are realized. Accordingly, the realization of human cognition in scientific practice is the product of a continuous re-integrating of the rational and technical aspects of its phenomenotechnical realization. What this points to is that a philosophical analysis of scientific practice should be one in which the mathematical aspects that shape how scientific objects are realized are included. For example, without taking into account that the realization human cognition requires the presence of a mathematical plane into which experimental results are integrated, the complexity of the phenomenotechnique within which the object ‘human cognition’ is realized cannot be appreciated.

5. CONCLUSION

Let me move back to the question posed at the start of this paper, and ask how Bachelard’s philosophy can help us answering the question how the ‘rational’ and the ‘practical’ are integrated in scientific practices? Bachelard’s notion of phenomenotechnique is crucial when connecting the rational and the practical. Introducing this notion has at least three different implications. Firstly, the realization of scientific objects is dependent on performing practical actions in relation with technologies. Secondly, the phenomenotechnique creates a rational plane—Bachelard’s noumenon—in which the complexity of scientific objects comes into being. Thirdly, the phenomenotechnique helps constituting a scientific city in which the epistemological obstacles grounded in the primitive experiences of individual scientists can be suppressed.

When considering these three different implications of approaching scientific objects as realized within a phenomenotechnique, it appears that the practical and the rational aspects of scientific practice are integrated in the realization of increasingly complex objects. The practical actions—for example in scientific experiments—are structured by a rational apodicticity, but the complexity created by such actions at the same time challenge existing standards of rationality. Bachelard maintains that we should understand the rationality of the scientific
project in terms of the way it is realized in the latest scientific developments, and that epistemology should incorporate this form of rationality. Taking into account the insight that scientific objects are phenomenotechnical realizations, an epistemology inspired by Bachelard allows to connect (i) the practical actions that scientists perform in relation with technologies, (ii) the rational apodicticity that allows to integrate a complexity that is revealed within scientific practice into a scientific object, and (iii) the way a socio-material environment is realized that supports the rationality of the phenomenotechnique.

The ongoing re-realization of scientific objects within the scientific project not only points to the interrelation of the practical and the rational on a micro-level, but also to ongoing changes on the socio-material level. By considering the rationality within the phenomenotechnique on a micro-level, Bachelard’s epistemology allows to develop a framework for the organization of the scientific city. For example, our discussion of the ‘dead salmon’ in §5 suggests that the realization of human cognition as a scientific object strongly depends on how it can be mathematically realized. This suggests that scientific subjects should be able to critically reflect on whether these mathematical realizations conform to their existing concepts of human cognitive functions. The phenomenotechnical realization of human cognition should therefore be accompanied with the realization of a socio-material environment in which the complexity of the phenomenotechnique can be appreciated. Accordingly, looking at the structure of the phenomenotechnique not only allows us to study the realization of scientific objects on a micro-level, but also to find a starting-point for how the socio-material environment in which science takes place could be rationally organized.
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2. In the French (continental) philosophical tradition, no strict distinction between ‘epistemology’ and ‘philosophy of science’ is made. In this paper, I will use these terms interchangeably.


9. The idea that our immediate encounter with reality is grounded in our primitive drives is why Bachelard occasionally refers to his project as a psychoanalysis of knowledge. See for example: Gaston Bachelard, *The Psychoanalysis of Fire.* Trans. Alan C.M. Ross. London: Routledge, 1964. A detailed analysis of this aspect of Bachelard’s philosophy is beyond the scope of this paper. For an excellent discussion on this topic, see for example: Cristina Chimisso, *Gaston Bachelard: Critic of Science and Imagination.* London: Routledge, 2013, 181-218.


24. Descartes made this distinction to make clear that his doubt was a methodological asset in his search for certain and indubitable knowledge, but should not be without hesitation be transferred to the domain of practical action. See: Descartes, Meditations, 16.
33. This implies that scientific theories or paradigms can never be fully discontinuous, as each new scientific theory necessarily develops in interaction with the erroneous scientific judgments that it aims to overcome. Despite their seeming similarities, it is on this point that Bachelard’s epistemology significantly differs from the Kuhnian notion of paradigm. See: Thomas Kuhn, The Structure of Scientific Revolutions. Chicago: University of Chicago Press, 1962. For further discussion on the relation between Bachelard and Kuhn, see for example: Stephen W. Gaukroger, “Bachelard and the Problem of Epistemological Analysis.” Studies in History and Philosophy of Science 7:3 (1976, 189-244), Dominique Lecourt, Marxism and Epistemology: Bachelard, Canguilhem and Foucault. Trans. Ben Brewster. London: NLB, 1975, 7-19. For an in-depth discussion of the mutual influence of Kuhn’s work and French epistemology, see: Massimiliano Simons, “The Many Encounters of Thomas Kuhn and French Epistemology.” Studies in History and Philosophy of Science Part A 61 (2017, 41-50)
38. For an extensive discussion of Bachelard’s notion ‘scientific city,’ see: Cristina Chimisso, Gas-
ton Bachelard: Critic of Science and Imagination, 198-201.


41. See: Bachelard, L’Activité Rationaliste de la Physique Contemporaine, 6-7.


43. The Ig Nobel Prizes are a counterpart to the Nobel Prizes, and are awarded to “achievements that first make people laugh and then make them think.” See: Improbable Research. “About the IG © Nobel Prizes.” Accessed September 12, 2017. http://www.improbable.com/ig/

44. Craig M. Bennett et al., “Neural Correlates of Interspecies Perspective Taking in the Post-Mortem Atlantic Salmon: An Argument For Proper Multiple Comparisons Correction,” Journal of Serendipitous and Unexpected Results 1:1, (2010, 2).
One thing that often strikes readers of Louis Althusser’s classic works *Pour Marx* and *Lire le Capital* as out of place, if not totally bizarre, is the constant references made to non-Marxist philosophers, indeed, to philosophers whose theoretical positions are commonly held to be thoroughly idealist. Looking perhaps for reader’s guides or introductions to Marx’s thought, they are met instead with Althusser’s passion for theory and scientificity. Classical Marxist themes such as exploitation, alienation, and commodity fetishism, not to mention class struggle, are hardly mentioned. After all, are not philosophers working in Marx’s wake supposed to be transforming the world and not merely contemplating it and producing various theories about it? Of course, it is well-known that Marx sought to settle his philosophical accounts with Hegel’s idealism (and his young leftist followers) and Feuerbach’s attempted materialist reversal of Hegel in texts such as the *German Ideology* and the *Theses on Feuerbach*. Althusser, in his typology of Marx’s work, classifies these polemical texts as so-called “works of the break,” that is, works wherein Marx had not yet fully articulated and elaborated the dialectical materialist philosophical position that would later be considered one of his greatest theoretical innovations—still under the shadow of German Idealism, Marx had not yet worked out the philosophical position his nascent historical materialism required. We even know today that Marx read and took extensive notes on Spinoza’s *Theological Political Treatise* as well selected fragments and correspondence in 1841, but certainly nowhere in these notes does Marx claim, as Althusser fa-
mously will, that Spinoza is “Marx’s only direct ancestor.” Rather, as Alexandre Matheron notes, it is difficult to conclude what exactly Marx gleaned from his reading of Spinoza, which is ultimately more of a montage of citations than a close reading: perhaps Marx projected his own ideas on to Spinoza or perhaps Spinoza was a kind of foil for Marx. Though Marx’s texts themselves do not directly make clear this relation of direct ancestry that Althusser posits, Pierre Macherey, one of Althusser’s most inventive and precocious students, ends his 1977 study Hegel ou Spinoza by drawing out this connection between Spinoza and the dialectical materialism Marx sought to found:

In what conditions can a dialectic become materialist? ...What is or what would be a dialectic that functions in the absence of all guarantees, in an absolutely causal manner, without a prior orientation that would attach to it, from the beginning, the principle of absolute negativity, without the promise that all the contradictions in which it is engaged are by rights resolved, because they carry within them the conditions of their resolution?

This would be, as Macherey suggests, a Spinozist critique avant la lettre of the Hegelian dialectic, that is, a truly materialist dialectic, a dialectic purged of all teleology. Althusser, for his part, only loosely seems to suggest this in an important footnote to his 1961 essay on the Young Marx. Whereas the Hegelian dialectic presupposes a “rupture in conservation,” that is to say, “a substantial continuity in the process” where the final stage of the dialectical movement contains the “truth” of the previous moments, Marx, Althusser claims, does not produce a science that would be the “truth” of a set of ideologies, but rather, establishes a new theoretical position that “constitutes a break [rupture] with ideology,” a break that does not result in ideology’s sublation and overcoming in the form of a science. Science does not take the place of an ideological problematic, but rather displaces it. Spinoza’s distinction between the three kinds of knowledge is the obligatory reference for Althusser, and decidedly not Hegelian Aufhebung: “Between the first and second kinds of knowledge, Spinoza established a relation that, in its immediacy (if we abstract from the totality in God) implies precisely a radical discontinuity [discontinuité radicale]. Though the second kind allows for the intelligibility of the first, it is not its truth.”

Althusser’s reference here to Spinoza contra Hegel in order to explain the event of the founding of Marx’s new science implicitly relies upon another non-Marxist reference: Gaston Bachelard, the great thinker of rupture and discontinuité radicale...
in the history of science and the formation of the scientific spirit. If a passionate Spinozism, as Althusser will confess in his *Éléments d’autocritique*, was a kind of antidote to the predominant structuralist tendency in French thought, so-called French Historical Epistemology is no doubt the other most important of Althusser’s non-Marxist references. Not only was Bachelard Althusser’s master’s thesis supervisor in 1947—though he apparently did not read a word of the *mémoire* on Hegel that Althusser submitted—but he will become for Althusser, beginning in the early 1960s, a point of reference, both nominally and conceptually, that will mark the entirety of his thought. However, Althusser’s fidelity to Bachelard, as well as to fellow travelers Jean Cavaillès, Alexandre Koyré, Georges Canguilhem, and Michel Foucault, earned him scorn among Marxist intellectuals. Michel Vâdée, writing in 1975, in fact dedicated an entire book to this topic. He writes in his *Bachelard ou le nouvel idéalisme épistémologique* that a Marxist philosopher turning to Bachelard represents “…an abandonment of the very foundations of the theoretical conceptions of Marx and Engels.” On this account, Bachelard, who Althusser invokes to defend Marxism’s scientificity turns out to be the source of the uncriticized idealist tendencies that Althusser smuggles into his reading of Marx at the expense of losing all materialist credentials!

What follows is a reconstruction of the way in which Althusser borrowed the philosophical category of “epistemological break” from Bachelard while simultaneously transforming its meaning and its theoretical function. In other words, Althusser does not simply mechanically apply the epistemological break to Marx, but rather in so doing, to borrow an expression from Canguilhem, varies “its extension and comprehension” and confers upon it “the function of a form.” Indeed, Alain Badiou writing in 1967 argued that Althusser implicitly defines dialectical materialism “...as being a formal theory of breaks [coupures],” that Althusser, in some sense, attempts to both formalize and generalize what in Bachelard’s work only remained a kind of philosophical refrain or theme that is never developed systematically.

What’s more, however, Althusser’s relationship to Bachelard changes in important ways as his own thought evolves. If the language of epistemological break—both *coupure* and *rupture*—and radical historical and epistemic discontinuity remain more or less consistent in Althusser’s work, the role that these categories play in his philosophical strategy change significantly. Put rather schematically, Althusser first employs Bachelard in order to produce a novel solution to a loosely Popperian problematic of demarcation, that is, appealing to Bachelardian epis-
temic discontinuity in order to guarantee, as it were, the distinction between science and ideology and to produce a theory of this very distinction. In a second moment, Althusser withdraws materialist philosophy from this epistemological debate and from theories of knowledge as such. This withdrawal no doubt corresponds directly to Althusser’s later claim in his explicitly self-critical texts that “philosophy is, in the last instance, class struggle in theory,” leading some to argue that this new politicized theory of philosophy “formalised the shift away from Bachelardian epistemology” while others used it as proof for the claim that “there never was an Althusserian epistemology.”

But, on the contrary, what I intend to show is that this redefinition of philosophy as class struggle in theory in fact signals a rapprochement between Althusser and Bachelard, and not the former’s abandonment of the latter. What will hopefully become clear is that Althusser paradoxically is able to ally himself more closely with Bachelard at precisely the moment when his initial philosophical project, the one propped up most explicitly by an appeal to Bachelard’s authority, collapses. By turning to recently published archival material, I aim to show that the Bachelard that Althusser initially constructed in fact evolved over the course of two decades.

Perhaps Althusser only became a faithful student of Bachelard over the course of many years and after laborious reformulations of his philosophical approach. And yet the culmination of Althusser’s engagement with Bachelard results in a kind of deconstruction of the classical problems of epistemology, what Badiou will call a “de-epistemologization of philosophy.” Tracking this désépistémologisation de la philosophie is precisely what I intend to do in the following sections by following the place of Bachelard in the development of Althusser’s thought from 1965 to the recently published manuscripts drafted in the late 1970s.

THE ROLE OF BACHELARD IN ALTHUSSER’S THÉORIE PROJECT

The explosion althussérienne, as François Dosse has called it, was fully underway in 1965 when Althusser published his two most well-known works, Pour Marx and Lire le Capital, in a new collection he was directing at the radical left-wing publishing house François Maspero. The new collection, bearing the name Théorie, was no doubt intended to be a larger platform for the philosophical research Althusser himself was inaugurating in the two aforementioned works. What exactly was the goal of this new philosophical undertaking? Althusser explains the Théorie proj-
ect in two places. First, in a short text included on the back cover of the original French editions of *Pour Marx* and *Lire le Capital*, Althusser explains that the Théorie collection will include texts and essays that will seek to define and explore “the field of a philosophy conceived of as Theory of the production of knowledges” and it is to be both “critical and positive.” Critical insofar as it will attempt to establish a non-idealist philosophical position and positive to the extent that it will propose categories “suited to think the forms and modes of the process of the production of knowledges.” This will in turn require a “theory of the structure of theoretical practice” and its difference from other practices, a “theory of the history of the production of knowledges” and its difference from other histories, and finally a “theory of the structure and the history of non-theoretical practices upon which theoretical practice is articulated.”

This three part theory—theory of theoretical practices, theory of the history of the production of knowledges, and theory of the structure and history of non-theoretical practices—is in fact already contained in Marx’s work. Dialectical materialism, as any Marxist knows, is the official name of this “new philosophical project.” However, as Althusser often points out, Marx devoted more time to the development of historical materialism and less time to developing the philosophy of dialectical materialism, which is left in *l’état pratique* in works like *Capital*. But the Théorie collection is also greatly inspired by “a certain number of original works in epistemology” as well as works on the history of ideologies and the history of knowledge and scientific research. This new collection will ultimately be the site of an encounter, une rencontre, of mutual “examination, exchange, and confrontation” between Marxism and certain works in epistemology and the history of science, which Althusser claims are from this point forward, indispensable to one another.

Second, Althusser adds one crucial clarification to this understanding of the Théorie project in a short section of *Pour Marx*, which is not included in the English translation. In a page-long text that appears between the introduction to *Pour Marx* and the book’s first chapter, Althusser explains why he has chosen to adopt the term Théorie. He writes, “the article on the Materialist Dialectic [sic] proposes the term Theory (with an uppercase) in order to designate Marxist ‘philosophy’ (dialectical materialism)—and reserves the term philosophy for ideological philosophies.” There is, however, as Althusser himself notes, a precedent for adopting this terminology. Althusser rather confusingly quotes Engels in what he calls “his first preface to Anti-Dühring,” by which he means what is today known as

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178 · david maruzzella
“The Old Preface to Anti-Dühring” or as “On Dialectics,” first published in 1925 as part of Dialectics of Nature. Engels writes: “If theoreticians are semi-initiates in the sphere of natural science, then natural scientists today are actually just as much so in the sphere of theory, in the sphere of what hitherto was called philosophy.”¹⁹ The emphasis here seems to be Althusser’s and he immediately follows up this quotation with commentary that reads: “This remark proves that Engels had felt the need to inscribe in a terminological difference the difference that separates ideological philosophies from Marx’s absolutely new philosophical project.”²⁰ A terminological difference is thus needed to account for a real theoretical difference, the difference that separates ideological philosophy from the “scientific philosophy founded by Marx.”²¹

This is the point at which Bachelard comes into play. Althusser, as announced in two introductory places in his seminal work, has proposed a terminological difference in order to account for what he insists is a profound theoretical difference between Marx and his predecessors. Théorie indicates that philosophy as it has been understood and practiced since its inception must, in light of Marx, be radically transformed. What is important, however, is that Althusser is not claiming that philosophy post-Marx need simply be replaced by revolutionary practice or class struggle, but rather that philosophy is itself a theoretical practice and in turn needs to be revolutionized and nourished by Marx’s theoretical discoveries. Indeed, this is the task of Pour Marx: to develop in the French idiom a distinctive contribution to Marxist philosophy.²² And Althusser’s wager is precisely that Marxist philosophy is qualitatively different from previous philosophical systems. Marx’s philosophy is scientific whereas all previous philosophies are ideological. This qualitative difference or “specific difference...thus takes on the form of the question of knowing whether or not in the intellectual development of Marx there existed an epistemological break [coupure épistémologique] marking the emergence [surgissement] of a new conception of philosophy.”²³ Immediately following this loose invocation of Bachelard, Althusser claims that a Marxist theory and method will be crucial in locating the site of this break: “without a theory of the history of theoretical formations we would not be able to grasp and designate the specific differences that distinguishes two different theoretical formations.”²⁴ Now comes the first mention of Bachelard in the book. Althusser tells us that his usage of the concept “epistemological break” is owed to Gaston Bachelard while the concept “problematic” comes from his friend Jacques Martin, despite the clear Bachelardian origins and resonances of the term.²⁵ In order to give an account of the specific difference between the scientific concepts put to work by Marx in Capital and the
ideological pre-history with which Marx broke, Althusser believed:

it possible to borrow for this purpose the concept of ‘problematic’ from Jacques Martin to designate the particular unity of a theoretical formation and hence the location to be assigned to this specific difference, and the concept of an ‘epistemological break’ from Gaston Bachelard to designate the mutation in the theoretical problematic contemporary with the foundation of a scientific discipline.28

Althusser’s project during this early period, as described by the young Jean-Luc Nancy, “is not any different than the Bachelardian analysis of the constitutions of modern physics, or the works of Koyré.”29 Indeed, Althusser endeavors to show that with Marx the theoretical problematic shifts, old philosophical questions are displaced, new concepts are produced and are in need of elaboration—a materialist dialectic that is essentially overdetermined, a theory of structural causality, a new theory of ideology, etc. Engels too, in his introduction to the second volume of Capital, underlines precisely that the history of science is defined by mutations and discontinuities. Marx’s discoveries in the field of political economy are analogous to Lavoisier’s discovery-production of oxygen, which led to the overturning of the phlogiston theory and the birth of modern chemistry.30 Just as Bachelard claims that “There is thus no transition between Newton’s system and Einstein’s system. We do not go from the former to the latter by amassing knowledges, double checking measurements, lightly rectifying principles. What is necessary, on the contrary, is an effort of total novelty,”31 Althusser too insists in Lire le Capital that with Marx we witness “the absolute beginning of the history of a science.”32 Engels is then, according to Althusser’s reading, a proto-historical epistemologist to the extent that he shows how an apparently circumscribed scientific problematic (phlogiston theory, bourgeois political economy) can give rise to an absolutely discontinuous new problematic that restructures the entire scientific field. Pour Marx, it might be said, attempts to establish the specific difference or rupture between dialectical materialism and previous philosophical systems (Feuerbach, Hegel), while Lire le Capital performs the same operation with respect to historical materialism by inquiring into the specific difference that separates Marx from the classical economists. Marx formulates the questions to which the bourgeois economists gave answers despite themselves, without realizing that the terms and stakes of the investigation must be fundamentally changed. The theory of symptomatic reading33 introduced by Althusser at this point in his exposé is meant to help detect these changes in theoretical problematics, but is never developed
Where would Althusser have found inspiration for such claims in Bachelard’s work? Althusser never gives any precise references to specific passages in Bachelard, but perhaps he had in mind the final chapter of *Le matérialisme rationnel*: “We believe,” Bachelard writes, “that scientific progress always displays a rupture, perpetual ruptures, between common knowledge and scientific knowledge, as soon as we approach an evolved science, a science which, due to the very fact of these ruptures, bears the marks of modernity.” Reading this passage alongside the one cited above where Bachelard describes a kind of incommensurability between the systems of Einstein and Newton, it becomes clear that “rupture” might here have a double sense: on the one hand, there are ruptures, to greater or lesser degrees, between different scientific theories, between different conceptual systems. In the example given above by Bachelard, it might be said that there is a rupture between Einstein and Newton, but also that Einstein’s theory restructures, redefines, and recasts the terms of Newton’s theory. On the other hand, there is another rupture, this time more absolute, between what Bachelard calls common knowledge and scientific knowledge. In short, science is, in this view, defined essentially by a break with everyday experience, immediate perception, and common notions. Bachelard of course also sought to analyze the way in which our ordinary experience crystallizes into images that in turn block the path of science, producing what he called “epistemological obstacles.” The history of science is then neither linear in a crude empiricist sense—science does not simply function by accumulating observations about an unchanging external reality nor is it the slow unveiling of pre-given truths—and a science’s development is impossible without the active intervention of concepts and techniques, without an applied rationalism and a technical materialism. This second sense of rupture even helps to make sense of Althusser’s famous theoretical anti-humanism: does not Althusser, like Bachelard, simply wish to say, by way of this polemical turn of phrase, that knowledge can never be the result of immediacy? Or as Bachelard put it, “when we turn towards ourselves, we turn away from the truth. When we have intimate experiences, we fatally contradict objective experience.” In other words, Marx does not produce the theory of the capitalist mode of production, that is, knowledge concerning a particular theoretical object, by appealing to first person experience, immediate perception, or to an uncriticized notion of “man”, but rather arrives at knowledge of this latter by way the detour of theory: “These men [real men] are thus the point of arrival of an analysis that begins with the social relations of an existing mode of production, class relations, and the
class struggle.” Science begins only by a step beyond immediate sensible experience, beyond what is given to consciousness. The phrase scientific knowledge is, as Georges Canguilhem remarked, a pleonasm since there is nothing scientific nor objective in pre-theoretical knowledge and our everyday experience of the world. In the world of phenomenological experience there is only error. In the language of Althusser, we might say that science begins by breaking with ideology and never ceases, beginning with this initial rupture, to break with itself. On this point Althusser and Bachelard certainly seem to converge.

Two points merit being addressed here concerning how Althusser transforms Bachelard’s thought. The first concerns Althusser’s claim, in Pour Marx and in contemporaneous texts, that Marx, unlike others who inaugurated scientific revolutions before him (the birth of Mathematics in the ancient world, Galileo, Newton, Lavoisier), in fact founded two distinct sciences, Historical Materialism and Dialectical Materialism. Indeed, as was suggested above, Althusser is claiming that with Marx philosophy becomes a scientific discipline for the first time in history. Althusser writes in “Matérialisme historique et matérielisme dialectique”, an untranslated text from 1966, that “Marx’s philosophy occupies a place of exception in the history of philosophy,” that is, like a science breaking with its ideological pre-history, Marx’s philosophy “presents this unique characteristic in the history of philosophy of breaking with this ideological past, and installing philosophy on new bases, which confer to it a character of objectivity and theoretical rigor comparable at every point to that of a science.” The details of what exactly Althusser means by this claim is admittedly not always clear, but he suggests that it is Marxism’s discovery of the continent of history and the development of historical materialism that allows Marxist philosophy to take the place of idealist theories of knowledge that, by their ignorance of the history of the production of knowledges, were doomed to “lack and mask the reality of history.”

Now this claim that Marx founded both a science of history and a scientific philosophy goes against the spirit and the letter of Bachelard’s project. Indeed, nowhere does Bachelard suggest that philosophy has or will ever itself become a unique scientific discipline. On the contrary, as Dominique Lecourt shows in his master’s thesis published in 1969 as L’épistémologie historique de Gaston Bachelard, Bachelard never tires of ridiculing philosophers who have failed to appreciate the innovative conceptual power of the sciences to displace classical philosophical problems. The philosopher, by and large, tends towards a double obfuscation of scientific practices. On the one hand, philosophers ignore the conceptual function of words
like “space”, “time”, “substance”, and “matter” in the scientific contexts in which they are produced. On the other hand, philosophy “wishes with science to get to the bottom of things. And in order to do so, it searches for origins. It returns to the rudimentary...and little by little introduces into the philosophy of sciences the most fully entrenched axioms of the philosophy of knowledge: the axiom that would have it that the primitive be always the fundamental.” Bachelard, against the ontologizing and fundamentalist ambitions of the philosopher of immediate experience and intuitive knowledge, precisely sought to se met à l’école des sciences, that is, to produce a philosophy subtle enough to be thoroughly informed by the scientific breakthroughs of the 20th century. “Science does not yet have the philosophy it deserves,” writes Bachelard in the opening chapter of Le matérialisme rationnel, and Althusser, for his part, is suggesting that with the advent of Marx’s dialectical materialism that philosophy is finally in a place to authentically understand the history of science conceived of as the history of the production of knowledges. Dialectical materialism is, in other words, the philosophy that science deserves.

Combined with Marxism’s historical analysis, Althusser no doubt thought it possible to develop a non-empiricist epistemology combined with a non-teleological history of scientific practices that would be able theorize the sciences as distinct historical theoretical practices that produce knowledges according to the immanent norms of their proper development without the need to appeal to external or extra-scientific criteria of truth. In this way, Althusser believes himself to have displaced all of the classical problems of epistemology or theories of knowledge. By classical problems of epistemology and theories of knowledge, Althusser has in mind a number of different philosophical positions. He explains in the recently published Initiation à la philosophie pour les non-philosophes, in a chapter entitled “Scientific Practice and Idealism”, that empiricism, formalism, and neo-positivism all share a common philosophical problematic, namely, they all attempt, from a position external to the scientific practice itself, to produce “guarantees” for the validity and objectivity of scientific knowledge, and in so doing, they presuppose the prior existence of certain necessary conditions of possibility and forms of experimentation that govern scientific practice. Philosophers then control and determine the validity and limits of scientific practice from an external position of authority. This externality, Althusser claims, has a precise political function as well: “The philosophical guarantee of science has changed its meaning; instead of basically serving the liberation of the sciences and of men, it becomes a principle of the authority of order.” Essentially a philosophy of order, the various strands
of idealism all seek to define, delimit, and control scientific practice (and political practice) by defining *in advance* the validity of certain forms of practice.

Materialism, on the contrary, seeks neither to prescribe forms nor to produce speculative guarantees for the content of particular practices. Instead, by conceiving of knowledge as the *effect* or result of distinct theoretical practices, as what is *produced* in and by thought by way of a process of conceptual labor—this is Althusser’s famous reading of Marx’s 1857 *Introduction*—Marxist philosophy is able to open up a new philosophical problematic distinct from that of the transcendental *a priori* conditions of the possibility of knowledge and experience (Kant) and that of the knowing subject (the ego cogito in Descartes or Husserl). Replacing it with a new set of questions and problems, in particular, the materialist epistemological question *par excellence* becomes thus:

*by what mechanism does the process of knowledge, which takes place entirely in thought, produce the cognitive appropriation of its real object, which exists outside of thought in the real world?* Or again, *by what mechanism does the production of the object of knowledge produce the cognitive appropriation of the real object, which exists outside of thought in the real world?*

In addition, this materialist epistemological question is inserted into a historical problematic. Althusser writes, for example, in a text from April 1965 that:

*The object of dialectical materialism is constituted by what Engels calls ‘the history of thought’, or what Lenin calls the history of the ‘passage from ignorance to knowledge’, or what we can call the history of the production of knowledges—or yet again, the historical difference between ideology and science, or the specific difference of scientificity—all problems that broadly cover the domain called by classical philosophy the ‘theory of knowledge’.*

Dialectical materialism both can help to address questions about how thought is capable, by means of a purely immanent process, of producing knowledge of the real. That is to say, as Nicos Poulantzas explains, “...producing the most concrete concepts, that is to say concepts that are the richest in theoretical determinations, which allow for the knowledge of real objects, concrete and singular” and permitting an historical understanding of how the distinction between science and ideology plays out in particular conjunctures. Indeed, Althusser writes in
the opening text of *Lire le Capital* that “Marx was only able to become Marx by founding a theory of history and a philosophy of the distinction between science and ideology.”52 Althusser, then, it might be said, hopes to use Marx’s materialist analysis of history in order to more fully flesh out a general theory of epistemological breaks or ruptures, that is to say, to reconstruct elements of Bachelard’s epistemological project on the basis of historical materialism.

This leads to the second point concerning the way in which Althusser transforms Bachelard. An important consequence that follows from integrating a theory of epistemological breaks into a materialist analysis of history is the need to produce a new theory of ideology. That is to say, a *materialist theory of epistemological obstacles*. Certainly one of Bachelard’s greatest merits was precisely to psychoanalyze objective knowledge, that is, to refuse to see the history of science as quarantined off once and for all from the intrusion of non-scientific elements, to argue that for the scientific mind that “Nothing goes without saying. Nothing is given. Everything is constructed.”54 Science requires perpetual effort and transformation, a constant vigilance, hence why Bachelard will claim that the philosophical rationalism that ought to accompany scientific practice is always at the order of a recommencement.55 And so if Bachelard seems to affirm, in his own way, that knowledge must be conceived of as an historical production, one shortcoming of Bachelard’s thought seems to be that the idea of epistemological obstacles is never put onto a materialist basis. Dominique Lecourt writes, for example, “It must be candidly stated: all that enables Bachelard to think the necessity of the ‘epistemological obstacles’ is a certain conception of the human soul which roots the ‘imaginary relationship’ in the imaginary images produced by the imagination.”56 In other words, Bachelard has yet to produce a materialist theory of ideology, one wherein the epistemological obstacle belongs not to the psyche of the individual scientist or some atemporal human nature, but is rather theorized as an instance in the social formation.57

**BACHELARD AS AN EPISTEMOLOGICAL OBSTACLE**

As I hope to have shown in the previous section, Althusser’s two 1965 publications, which sought to reinvigorate Marxist dialectical materialism—re-baptizing it as *Théorie* so as to mark its qualitative difference from all previous philosophical inquiry—results in its identification with an historical epistemology as well as in Althusser’s more elliptical claim that this encounter of Marxism with the works of Cavaillès, Bachelard, Koyré, Canguilhem, and Foucault will aid in securing the
scientific credentials of both historical and dialectical materialism. It should of course be noted here that Althusser’s argument is explicitly circular and he admits as much. In order to read Marx we must have at our disposal “a Marxist theory of the differential nature of theoretical formations and their history, that is to say a theory of epistemological history, which is Marxist philosophy itself.”

Echoing this point Pierre Macherey writes in his contribution to *Lire le Capital*:

> Philosophy is nothing other than knowledge of the history of sciences. Philosophers are today those who produce the history of theories, and *at the same time* the theory of this history. The problematic of philosophy is thus double, but not divided: to philosophize is to study *in what conditions* and *on what conditions* scientific problems are posed. For a materialist, these conditions are not purely theoretical: they are first of all objective and practical.

Again, the circularity or double aspect of Marxist philosophy—Althusser suggests at one point that this is in fact what makes it dialectical—implies that, employing the concept of history elaborated in historical materialism, it will be able to give a rigorous account of the historical production of knowledges and their difference from ideologies. This can then in turn be applied to historical materialism in order to show the shift in problematic from classical bourgeois economy to Marx’s *Capital* and to dialectical materialism in order to show the shift in problematic from mechanical materialism and idealist dialectics to Marx’s new historical materialist epistemological problematic. In other words, by claiming that Marxist philosophy is founded precisely on theorizing the historical difference between science and ideology, Althusser believes that he has proven, in some sense, that both historical and dialectical materialism have earned the title of science. Their retrospective differences with respect to previous theories allows us to draw a line of demarcation between science and ideology.

Yet there is precisely a contradiction at the heart of Althusser’s attempt to use Bachelard to help establish both the scientificity of Marxism and to develop the theory of the specific difference between science and ideology that essentially defines Marxist philosophy. The problem is not simply that Bachelard nowhere treats Marxism as a science and devoted none of his efforts to establishing its historical emergence as a unique scientific discourse—focusing instead on physics, chemistry, and mathematics—but rather that nowhere does Bachelard attempt to develop a general theory of scientificity, that is, a general theory of the differ-
ence between science and ideology, science and non-science. Furthermore, in the absence of such a theory, Bachelard never seeks to prove scientificity by seeing particular sciences as evidence for the validity of his general theory, but rather, he seeks to reorient philosophy in the light of the development of particular sciences, demanding that philosophers reform their ontologizing and foundationalist projects alongside and after the sciences recast and transform their concepts and problematics.

For Bachelard then, science leads the way and philosophers should follow, not the other way around. And as the sciences become more specialized and plural, the more it is necessary for philosophy to abandon its attempts at hierarchizing and systematizing knowledge into one coherent over-arching system. If there ever was ever a Bachelardian revolution in philosophy, it lies precisely in this reversal of determination and the demand that a scientifically enlightened philosophy be produced, one attuned to the complexities and subtleties of contemporary physics, chemistry, and mathematics: “When everything changes in culture, and methods and objects, we might be surprised that philosophical immobility is valued. Such a philosopher who at 60 years of age that he is still defending the claim he defended 30 years ago. The entire career of certain philosophers today is thus a ‘constant defense.”’ Philosophs for Bachelard, would do well to stop defending their tried and true positions and instead open themselves up to a productive dialogue with the sciences. Though Althusser seems to affirm this view throughout his work, it is arguably nothing other than this idiosyncratic use of Bachelard that creates a kind of epistemological obstacle for Althusser, an obstacle that he will have to address directly in the years following Pour Marx and Lire le Capital. In fact, it is only in subsequent texts that Althusser will claim that philosophy exists in the wake of scientific and political revolutions, that is, that philosophy is conditioned by science and politics.

Étienne Balibar directly addresses these problems in his 1977 talk “The Concept of Epistemological Break from Bachelard to Althusser.” There, Balibar suggests that the appeal to Bachelard indeed feels like an attempt to guarantee the scientificity of Marxism—keeping in mind that Althusser’s materialist epistemology appeared not to concern itself with guarantees or juridical (transcendental) questions, but only sought to understand the mechanism by which thought produced knowledge of the real. In other words, the appeal to Bachelardian epistemic discontinuity becomes for Althusser a kind of argument by analogy that Althusser imports into his discussion of Marx. In turn, Althusser seeks a kind of external guarantee.
or verification for the scientifcity of Marxism in the figure of Bachelard, that is to say, in something extrinsic to the scientific theoretical practice itself:

We can then no longer escape, in one form or another, the hypothesis of an essence of Science [LA science], the object of a general Theory that cannot be absolutely distinguished from a theory of knowledge or a Science of sciences (even though Althusser directs his whole polemic against such an idea...we might even ask ourselves if...the concept of ‘epistemological break’ is not for Althusser an ad hoc concept intended in advance to include Marxism (and psychoanalysis) in the field of science.  

By making use of the category of rupture or break in this way, Althusser tried to formalize a general theory of breaks that would itself be inscribed in the a general theory of the history of sciences conceived of as an historical process of the production of knowledges.

And yet it is this appeal that directly violates, on Althusser’s own terms, one of the crucial aspects of Bachelard’s thought that he also defends in the same breath, namely, the requirement that a science’s criterion of truth and validity be purely immanent to its operation. As Alain Badiou rightly points out, “Althusser is truly an immanentist thinker, at every level of its determination. A truth of a theory—if truth exists, if there is something like truth—lies purely within the theoretical process, inside the process of scientific theory and not in the value of an external guarantee.”

After all, Althusser, again reasoning analogically, writes in Lire le Capital that “No mathematician waits for physics, where entire parts of mathematics are applied, to have verified a theorem in order to claim that it has been demonstrated: the ‘truth’ of the theorem is supplied to it 100% by criteria purely internal to the practice of mathematical demonstration, thus by the criteria of the mathematical practice.” Mathematics needs nothing other than itself to legitimize itself, its criteria of truth and normativity are strictly internal to its practice and rely neither upon empirical verification or falsification nor upon any other discourse, such as physics.

But the Théorie project, for all its talk of immanence and internal criteria of truth, and despite its attempts to defend the practice of sciences against appeals to transcendental conditions of possibility and empiricist theories of knowledge that seek to ground scientific practice in verification or falsification procedures—what Althusser calls pragmatism—ultimately seems to be propped up by the impor-
tation of the Bachelardian theme of discontinuity as the marker, indeed the hallmark, of the birth of a science.

To my mind, to put it a rather schematically, Althusser has indeed transposed the Bachelardian language of rupture and break into a context—the political-polemical not to mention theoretical context of defending the scientificity and novelty of Marx—where this very notion serves a function incompatible with Bachelard’s project, that is to say, Althusser sees in the category of “epistemological break” the possibility of producing, to borrow an expression from Karl Popper, a “criterion of demarcation.” In order to distinguish between science and pseudo-science, to exclude Marxism and Psychoanalysis from the kingdom of science, Popper famously argued that a science must specify the conditions under which crucial experiments might come to falsify the conjectures that define a scientific theory. Despite the explanatory power of Marxism and its apparent systematic coherence, it, like Freudianism and Adlerian individual psychology, seemed to be able to explain everything and saw every event as a confirmation of an overarching theory that could not be disproven.67

Without entering into the details here, it seems to me that Popper and Althusser are in agreement up to a certain point: a science can never be a theory of everything, but rather must produce knowledge of a particular object. For Althusser, what is most important is that the object be constructed in theory—and Althusser is quite clear that Marxism, at least historical materialism, produces knowledge of the theoretical object known as the “capitalist mode of production”—and not confused with real objects existing in the world.69 Popper, however, implicitly remains an empiricist—despite his attempts, for example, in his response to Kuhn where he argues that he always maintained that scientists work within a particular paradigm or “problem situation” and thus maintains that sciences construct their objects in some sense—since he explicitly establishes himself in the wake of Hume’s problem of induction: given that I am limited to my experience, I can never exhaustively verify or confirm a given scientific theory, but at the very least I can hope to falsify it. Though Popper’s reversal here is no doubt innovative, it still relies essentially upon the finitude of the knowing subject whose representations limit it to the domain of experience from which it cannot be extracted.70 Science post-Hume is then not hopeless, rather, it simply does not proceed inductively and by way of verification, but deductively and negatively, by way of falsification. Falsification can thus finally be elevated to demarcate or distinguish between science and non-science. The explanatory power of Marxism might be
interesting, but it is certainly cannot be considered scientific if its practitioners cling to it dogmatically.\textsuperscript{72}

For Althusser, however, demarcation, if we can rightly call it that, takes the form of a historical process, which is already many steps beyond the rigidity of falsification, a notion that many, including Thomas Kuhn have criticized as being an untenable and unfounded in the history of science.\textsuperscript{73} All theories are falsified all the time, especially when they are first introduced.\textsuperscript{74} Bachelard masterfully articulates this point: “All knowledge at the moment of its construction is polemical knowledge [i.e. neither falsified nor verified]; it must first destroy to clear a space for its constructions.”\textsuperscript{75} Althusser’s historical process of demarcation is above all retrospective, which means, unlike Popper, we cannot appeal to one eternal criterion, “methodological falsification,” which would allow us to know in advance which theories are scientific and which are not. The field of differences and distances that relate sciences and ideologies is never determined once and for all and is above all polemic, defined by relations of forces and shifting conjunctures leaving open the possibility of new forms of rationality. In a 1967 article, “The Humanist Controversy,” Althusser most explicitly explains the nuances of his thinking on this question:

The ideology/science opposition is thus always based on a \textit{retrospection} or \textit{recurrence}. It is the existence of science itself which establishes the ‘break’ in the history of theories which can then serve as the grounds for declaring the prehistory of science \textit{ideological}. This break and this retrospection are, however, the correlatives of a real process, that of the constitution of science (born in ideology) through theoretical work that leads up to a \textit{critical} point which explodes in a break, instituting the new field in which the science will establish itself. Whence a paradox: science is plainly born of ideology and in ideology—yet the ideology of which science is born as it tears itself away from ideology can be given the name ideology only by the science born of it and separated from it.\textsuperscript{76}

Critics, and there are still many, who accuse Althusser of a rigid and clean distinction between science and ideology would do well to read this important passage.\textsuperscript{77} The “post-structuralist” critique, in many ways influenced by Rancière, that all sciences are ideologies or that there is ultimately no way to differentiate between the two, was already anticipated by Althusser: the sciences swim perpetually in ideology and yet still remain irreducible to it to the extent that scientific practice
produces effects of knowledge distinct from ideology’s effects of recognition. In other words, there is still something, some excess or rather, some effect that science produces that ideology, strictly speaking, cannot. And in this sense, it is not clear that the distinction science/ideology directly maps onto the distinction science/non-science; ideology is not the opposite of science, but rather a different practice occupying a different theoretical space. Everything hangs on this distinction between opposition and difference.

But to return to Balibar’s point, we must insist on the question: does Althusser simply make use of Bachelard’s terminology merely to produce a definition of science that would include, against the prohibitions of Popper, Marxism and Psychoanalysis? Yes and no. This very tension traverses two important texts by Étienne Balibar that justify our hesitant response. In a 1988 article “Coupure et refont: l’effet de vérité des sciences dans l’idéologie,” Balibar distinguishes Althusser’s project from Popper’s: “Far from being able to disintricate them in advance, the concepts of science and those of ideology only begin to exist after the fact of the break.” Against Popper, as we have already seen, nothing comes before the break and the demarcation between science and ideology is strictly retrospective. Thus for Balibar, if nothing comes before the break that distributes and redistributes the positions assigned to sciences and ideologies, then Althusser’s problematic has nothing in common with Popper’s. Yet, in Balibar’s earlier article on the concept of epistemological break, he is forced to admit that despite Althusser’s best efforts that he remains “caught in the relation of the specular ‘guarantee’ that he never ceased to describe: in order to be able to think the ‘epistemological break’ of Marx, he had to anticipate its form by invoking the epistemological breaks typical of mathematics, physics, and chemistry...‘Bachelard’ is then the guarantor of this non critical anticipation.” In other words, Althusser’s argument in this period reasons by analogy and assumes that the breaks that define the history of mathematics, physics, and chemistry can simply be identified in the formation of all sciences, including Marxism and Psychoanalysis. Althusser, in other words, might have, despite himself, produced the very philosophy of immobility that Bachelard never ceased to decry.

On the one hand, it appears that Althusser transforms Popper’s problematic by making the the science/ideology distinction the result of an immanent and historical process where the two terms do not pre-exist their retrospective distinction. On the other hand, in order to establish this distinction, even minimally, and even if it only is produced après coup, after the break, Althusser needs the category of
epistemological break he borrows from Bachelard to guarantee scientificity. If one can locate a break between two theories then one has successfully baptized a new science. This ultimately requires the intervention of a historical epistemologist, in this case Althusser, capable of reconstructing the historical process by which the new science is born out of an ideological configuration, subsequently making the ideology appear, for the first time, as ideological. In the same text that was cited above where Althusser provides a sophisticated account of retrospection, he writes that “If Marx had not produced the new concepts appropriate for thinking the objects of his discovery, we would not be able to pronounce the Judgement of ideology that we apply to the notions with which he had to break.”

It is Althusser here who capitalizes the J in Judgement and insists that it is indeed a question of a retrospective judgement that is capable of identifying ideology in the theories with which Marx broke on the basis of Marx’s new scientific concepts. Again, to even distinguish minimally between science and ideology one must have recourse to a judgement, which in turn presupposes a criterion of demarcation. It is worth recalling that the Greek kriterion means principle, element of reference that permits adjudication, estimation, or the defining of something as well as, in mathematics, a practical method permitting one to very if a mathematical object possess or not a determinate property. Marxism’s scientificity is thus in the hands of dialectical materialism, that is, in the hands of philosophy, and not immanent to its theoretical practice.

**ALTHUSser’S DECONSTRUCTION OF EPISTEMOLOGY**

What I would like to propose in this final section is that, if Althusser wants to defend a theory of science wherein normativity and a knowledge producing power are immanent to scientific practice while maintaining that Marxism is a science, then what needs to change is precisely Althusser’s definition of philosophy as Théorie. In turn, he must, on his own terms, renounce both that Marxist dialectical materialism is a scientific philosophy and that Marxist philosophy, scientific or otherwise, takes as its object the historical difference between science and ideology. This, I maintain, is the major focus of Althusser’s self-critical period and is the only way to begin to understand Althusser’s subsequent writings such as the 1968 talk “Lenin and Philosophy” and its final claim that Marxism is not a new philosophy of practice—indeed, from now on there is no such thing as a new philosophy for Althusser—but a new practice of philosophy. Far from being “the most obscure and sterile moment of Althusserianism,” “the least profound text Althusser ever published,” or “sheer non-sense,” Althusser’s re-discovery of
Lenin’s philosophical writings is the necessary philosophical adjustment needed to escape the aporias of Théorie. Though many associate this Kehre with the publication of Éléments d’autocritique in 1974, Althusser, in many places, indicates that he in fact began questioning the efficacy of the Théorie project as early as the autumn of 1967. Indeed, it could easily be shown that the self-critical phase begins with Althusser’s “Philosophy Course for Scientists,” a lecture series he held at the École Normale Superieure during the 1967-68 academic year (not published, and only partially, until 1974) and which marked an important shift in the Althusserian theory of science and its relationship to philosophy.

What is essential in this period is that Althusser fundamentally changes his definition of philosophy. No longer is Marxist philosophy concerned with answering epistemological questions such as the one posed at the end of the introduction to Lire le Captail, namely, the supposedly materialist question of the cognitive mechanism by which thought grasps the real in thought, nor does it attempt to produce a general theory of science and scientificity (the passage from ignorance to knowledge), rather, philosophy is henceforth defined as a distinct theoretical practice without an object, and will later become nothing other than class struggle in theory, the continuation of the proletarian class struggle in the domain of theory. If philosophy no longer produces a general theory of science it is because philosophy now defends the scientificity of science in the class struggle in theory—like in Bachelard, philosophy for Althusser becomes essentially polemical and functions by drawing lines of demarcation between idealist and materialists theses. Thesis 20 of Althusser’s course reads: “Philosophy has as its major function to trace lines of demarcation between the ideological of ideologies on the one hand, and the scientific of the sciences on the other hand.”

This change of language is important even if subtle. Althusser’s claim is precisely that philosophy no longer produces a theory of scientificity and ideology in general, that its essential to task to theorize the historical passage from ignorance to knowledge, but rather that philosophy is now said to intervene in the theoretical domain of the philosophical by drawing lines of demarcation or distinguishing between the scientific-ness of the sciences and the ideological-ness of ideologies. In other words, it mobilizes distinctions in a polemical theoretical field to produce certain effects, to produce a defense of scientificity against the ideological, but without producing a general epistemological theory or seeking philosophical guarantees for the legitimacy and validity external to scientific practice. As Giorgos Fourtounis writes, “Marxism’s epistemological claim can function epistemologically only as a thesis...and thus it is not submitted to a judgement that would operate by subsuming Marxism under
a general concept of science produced in turn by a philosophy external to it.\textsuperscript{988}

By producing a finally object-less philosophy, Althusser can begin to assume the materialist position he had been sketching throughout his earlier works against the juridical-epistemological position essential to idealism:

It is not by chance if, in order to respond to the ‘question of right’, the classical theory of knowledge puts to work a category like that of the ‘subject’ (from the Cartesion ego to the Kantian transcendental Subject and ‘concrete’ Husserlian transcendental subjects). This category is only the reprise, in the philosophical field, of the ideological notion of the ‘subject’, itself taken from the juridical category of the ‘subject of right’. And the couple ‘subject-object’, ‘the subject’ and ‘its’ object, only serve to reflect in the philosophical field, and within a properly philosophical mode, of the juridical categories of the ‘subject of right’, ‘owner’ of itself and of its goods (things). Thus ‘consciousness’ is the owner of itself (self-consciousness), and of its goods (consciousness of its object, its objects)… From this analysis we will thus retain the following: the immense majority of philosophies, whether religious, spiritualist or idealist, maintain a relation of exploitation with the sciences. This means: the sciences are never taken for what they really are… exploiters, in general, and not only in philosophy, never have the impression of being exploiters.\textsuperscript{89}

It seems to me, that in such a passage, Althusser has re-oriented and re-adjusted his theory of philosophy—and important to Althusser’s thought in this period is the claim that philosophical theses are indemonstrable, neither true nor false, but rather ‘correct’ [justes]\textsuperscript{90}—so as to let philosophy operate polemically, not in order to control or limit scientific practice, but rather to aid scientists in overcoming their spontaneous philosophical prejudices. Materialism, though its historical forms change\textsuperscript{91}, always seeks to defend, and not prove, the real existence of diverse scientific practices producing knowledge of well-defined theoretical objects, while idealism searches for conditions of possibility, guarantees for the objectivity of knowledge, and poses insurmountable obstacles to what is knowable, insisting on the finitude of the subject before an unknowable reality that constantly recedes from thought.\textsuperscript{92} Like Bachelard, Althusser is attempting to produce the philosophy that the sciences deserve, one that does not exploit them for the sake of practical ideologies, but rather is allied with them, that shares their values and interests. Philosophy intervenes in historically determined theoretical
struggles and conjunctures in order to defend scientificity and objectivity without producing epistemological theories. To take a position in theory, Althusser is suggesting, is thus always a political undertaking, that it is to say, the representation of a class position within a specific conjuncture. Epistemology qua theory of knowledge, Althusser tells us in a long footnote of his Elements d’autocritique is an idealist undertaking by definition since it always attempts to justify the self-legitimating and self-norming scientific practices in a discourse extrinsic to the scientific practice itself. Materialism, by refusing to see knowledge as a problem to be solved philosophically, displaces the classical epistemological problematic, making the objectivity and existence of scientific knowledge a thesis to be defended, not justified philosophically.

During this period, Althusser was no doubt influenced by the works of his young student, Dominique Lecourt, who was one of the first to systematically and explicitly spell out the theoretical kinship between Bachelard and Althusser. In recently published manuscripts such as Initiation à la philosophie pour les non-philosophes and Être marxiste en philosophie, Althusser positively cites Lecourt’s 1973 book, Une crise et son enjeu, where Lecourt analyzes at length Lenin’s non-epistemological defense of scientific objectivity and his specific way of intervening into the class struggle in theory against the philosophical position known at the time as empirio-criticism. Led by Ernst Mach, the Austrian physicist and philosopher, empirio-criticism sought to marry idealism and materialism into a new epistemological and ontological theory. However, following Engel’s famous claim that the history of philosophy is an age-old struggle between idealism and materialism, Lenin, as read by Lecourt, shows how empirio-criticism is simply the wolf of idealism in sheep’s clothes—philosophy is thus this strange theoretical practice where every position is already accounted for, “every space in the first is already taken,” and within which there appears to be no history other than “a history of the displacement of the indefinite repetition of a null trace whose effects are real.” For Lenin, Mach only re-packages and repeats Hume and Berkeley, forcing Lenin to play the role of Diderot against them. There is then, no third way, no position outside of the struggle between materialism and idealism, and the task of dialectical materialism, is to affirm and defend the following theses in the following order: 1) being has primacy over thought, or the primacy of practice over thought 2) there are scientific practices that produce objective knowledge.

Arguably Althusser too read Lenin’s Materialism and Empirio-Criticism seriously for the first time beginning in 1967, that is, after having complained to Franca
Madonia in a letter from December 1962 that he is “reading (rereading) Lenin’s theoretical texts philosophy. God, its weak.” This is the very same Lenin, and for that matter, Engels, that Althusser too quickly dismissed in his writings from the early 1960s with the single exception being a little-read article from 1964, which served as an introduction Pierre Macherey’s systematic reading of Georges Canguilhem in the article “Georges Canguilhem’s Philosophy of Science: Epistemology and History of Science.” Here Althusser suggests that Lenin was the first to realize that rationalism need not be idealist, but might in fact be compatible with dialectical materialism. However, this new encounter with Lenin is absolutely crucial—Althusser suggests as much at the end of his second lecture in the course for scientists. It is as if, writes Warren Montag, “his earlier view of Lenin is not simply corrected or rejected in 1967-68, but is strangely reversed, as if Althusser’s initial denial of the perpetual war in and of philosophy simultaneously affirmed and denied the nature and stakes of this conflict, leaving them visible even as he crossed them out.”

It is typically thought that Althusser wrote and published little during the 1970s, that is, after the events of May 1968, which cemented his status an intellectual out of touch with popular movements. The supposed silence on Althusser’s part is today being contested by the discovery and publication of complete manuscripts at the IMEC archives in Caen that Althusser had composed during this time. As the title of Lecourt’s second book already suggests—Pour une critique de l’épistémologie, for a critique of epistemology—there is something fundamentally incompatible about the classical project of epistemology and philosophical materialism, two opposing projects that Althusser once sought to unite by way of Bachelard. In the preface to the English edition of Lecourt’s early writings, Marxism and Epistemology, Lecourt sketches an underground materialist current that runs from Spinoza to Bachelard, by way of Marx and Lenin. After citing a passage from L’activité rationaliste de la physique contemporaine where Bachelard describes the role of rational values that impose themselves autonomously in the history of a scientific practice, Lecourt writes:

Bachelard is stating...the philosophical thesis that underpins all his epistemological works: that the truth of a scientific truth ‘imposes itself’ by itself. In Spinozist terms: ‘veritas norma sui’ (the truth is its own measure). In Leninist terminology: Bachelard is posing the thesis of the objectivity of scientific knowledges. He is posing it, not discussing it. He does not seek to found, to guarantee this objectivity. He is not concerned to pose to sci-
cientific knowledge the traditional question of its claims to validity. This point is crucial, for we maintain that this position is a materialist position. A position which enables to take a step outside the theoretical space of what idealist philosophy in its classical period called the ‘problem of knowledge.’

The materialist position in philosophy according to Lecourt, who clearly is developing Althusser’s thought on this point, consists in refusing to make scientific knowledge’s possibility and its objectivity problems to be solved by philosophical speculation. To attempt to solve them interior to philosophy can only lead to theories of objectivity, validity, and truth that are external to the scientific practices in question. The history of philosophical idealism is, according to Lecourt and Althusser, an attempt to solve a problem that simply does not exist for Spinoza, Bachelard, and Marxism-Leninism.

A similar declaration is made by Althusser in his Étre marxiste en philosophie, an introductory philosophy manual he completed drafting towards the end of 1976 before abandoning the manuscript. Spinoza and Marx, writes Althusser, affirm the existence of scientific knowledge “without any commentary.” Spinoza’s Habemus enim ideam veram is for Althusser a primitive fact on the basis of which materialism must intervene against all forms of idealism. The same goes for Marx who, according to Althusser, “begins from the fact that knowledges exist, some scientific, others not…and thus rejects the possibility of a prior juridical question.”

Materialism thus seeks to defend the scientificity of scientific knowledges without first posing juridical questions about the subject’s right or cognitive ability to know. Althusser, though he had attempted to critique the juridical foundations of epistemology in Lire le Capital, ultimately repeated the very same problematic by posing the question of the cognitive mechanism by which thought grasps the real. Hence why Badiou argued in 1967 and more recently that Althusser’s early epistemological problematic requires a kind of Kantian schematism to link thought to the real, to explain how the real object remains distinct from the object of knowledge and how theoretical concepts help to organize our understanding of the empirical world. Returning in the mid-1970s to Marx’s 1857 Introduction, the same text that Althusser commented on at length in 1965, he now argues that Marx sidesteps the entire problematic of epistemology and the theory of knowledge as such “by his simple silence with respect to every question of right, which constitutes the idealist theory of knowledge as a theory of knowledge.” Like Spinoza’s true idea, Althusser describes a Marx advancing almost axiomatically
Marx begins from the fact that knowledges exist, some scientific, others not. To begin then from the fact (in Spinoza like in Marx) is clearly to refuse the question of right (what can man know, his faculties being what they are?), it is to refuse that idea that we should have to pose to the fact of knowledge (non-scientific then scientific) the question of its titles of legitimacy: for example, the question of knowing if metaphysics, rational psychology (which deduces the properties of the human subject from its faculty of thought and of freedom), rational theology (which deduces from the total perfection of God his faculties and intentions), rational cosmology (which deduces the world's properties from its unity) are or are not scientific knowledges, and the question of what (in chemistry or in psychology) scientific knowledges that man might someday attain, etc. This is—and we must not shy away from it—a very strong idea, which amounts to recognizing the primacy of the fact and the derivative character of right, which rejects the possibility of a prior juridical question...

This long passage indicative of what might be called Althusser’s deconstruction, or even destruction, of epistemology, resonates with a similar remark Althusser makes in the contemporaneous “Sountenance D’Amiens” where Althusser again treats Spinoza’s *Habemus enim ideam veram*:

What does Spinoza in fact mean when he writes in a famous phrase, “*Habemus enim ideam veram*...”? That we have a true idea? No: the weight of the phrase lies on the “*enim*”. It is *in fact* because and only because we have a true idea that we can that it is true, because it is “*index sui*”. Where does this true idea come from? That is quite a different question. But it is a fact that we do have it (*habemus*), and whatever it may be that produces this result, it governs everything that can be said about it and derived from it. Thus Spinoza in advance makes every theory of knowledge, which reasons about the justification of knowledge, dependent on the *fact* of the knowledge which we already possess. But this does not prevent Spinoza from talking about knowledge: not in order to understand its Origin, Subject and Justification, but in order to determine the process and its moments, the famous ‘three levels’...

Spinoza, like Marx, Lenin, and Bachelard, it seems, give us knowledge without epistemology, that is without a foundationalist justification for its possibility and
existence, and without the elaboration of the origin of knowledge (in the subject or the object) or the subject’s right to know or possess such knowledge. A materialist epistemology, writes Lecourt in his Bachelard: Le jour et la nuit, is a true “theoretical monstrosity,” and the Althusser post-1967 would no doubt agree. To enter in the field of classical epistemology is to admit necessarily that scientific knowledge is a problem and that its existence must be justified and secured philosophically by a theory of knowledge that guarantees its objectivity, validity, as well as a theory of the subject’s right to knowledge. The true materialist position, as Lecourt explains in his treatment of Lenin, is to simply affirm that objective scientific knowledge exists. Marxist philosophers caught up in the class struggle in theory are then tasked with defending the unique knowledge produced by historical materialism, since, as Lenin once said, it is the only knowledge whose truth implies the complete and necessary destruction of the prevailing capitalist mode of production. If Marxism is an exceptional in the history of sciences, it is because the knowledge it produces is directly implicated in the political practice of the proletarian class struggle. This is why Althusser will later say in his essay “Sur Marx et Freud” that Marxism and Psychoanalysis are conflictual sciences.

We can thus say that Althusser’s philosophical position was always a kind of “scientism,” as William Lewis has recently argued insofar as scientific knowledge was always considered politically efficacious and essential when inserted into the proletarian class struggle. What changed, however, was Althusser’s theory of philosophy, which shifted from attempting to produce novel solutions to classical epistemological problems, to contesting and refusing epistemology as such. Philosophy was always a distinct theoretical practice for Althusser, but the nature of this peculiar practice changes drastically between 1965 and 1967. Materialism affirms the prior existence of scientific knowledges and seeks to defend them in theory; philosophy is then a theoretical practice of intervention, of drawing lines of demarcation between necessarily opposed and incompatible positions. One way to recognize idealism, Althusser seems to be suggesting, is to look for epistemology and theories of knowledge. Against the earlier writings from Pour Marx and Lire le Capital, Althusser, beginning in 1967, undertakes a deconstruction and destruction of the classical theory of knowledge that he once that Marxism could produce, but only at the cost of repeating Kant’s schematism and Popper’s problem of demarcation. Althusser’s rejection of epistemology, however, is coupled with a militant defense of scientificity, knowledge, truth, and objectivity making his thought anathema to post-modern philosophers. It is a question of defending the knowledge produced by Marxism that is ultimately crucial to the working
class’ struggle against capitalist exploitation. Defending the scientificity of Marxism means to recognize the power and efficacy of knowledge in class struggle at the theoretical, political, and ideological levels.

To conclude, I would like to emphasize again that despite positively citing Bachelard throughout his entire philosophical career, Althusser only ever becomes a materialist and a faithful Bachelardian by eliminating precisely the epistemological problematic that defined the theoretical stakes of *Pour Marx* and *Lire le Capital*, which are perhaps the two Althusserian works most explicitly indebted, but only on the surface, to Bachelard. As soon as the question of the scientificity of science ceases to be the central Althusserian philosophical question Althusser can authentically assume Bachelard’s thought. To be a materialist, Marxist and a Bachelardian in epistemology means quite simply to no longer do epistemology in the classical sense. Alain Badiou is absolutely right to claim that Althusser initiated a radical “de-epistemologization of philosophy.” Whence the paradoxical conclusion: Althusser is one of the most important inheritors of French historical epistemology precisely at the moment when he refuses epistemology.
NOTES AND ACKNOWLEDGMENTS

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5. Pour Marx, n40, 75.
6. Ibid., n40, 75.
9. It is worth mentioning that, as Étienne Balibar and others have pointed out, Bachelard does not use the language of coupure épistémologique. He speaks rather of a “rupture épistémologique” on page 104 of Le rationalisme appliqué and of a “rupture entre connaissance commune et connaissance scientifique” on page 102 of this same book. The final chapter of Le matérialisme rationnel also treats the rupture between common and scientific knowledge. Balibar is right to claim that the point of commonality between Bachelard and Althusser seems to be more generally the “idea of discontinuity”. See Balibar’s essay “Le concept de ‘coupure épistémologique’ de Gaston Bachelard à Louis Althusser” in Écrits pour Althusser (Paris: La Découverte, 1991). Balibar will go on to expand his treatment of Althusser and la coupure épistémologique in his essay “L’objet d’Althusser” in Politique et philosophie dans l’oeuvre de Louis Althusser sous la direction de S. Lazarus (Paris: PUF, 1993).
12. Though I am certainly not the first to have pointed out the role of the demarcation problem in Althusser’s thought, I tend to side with Étienne Balibar’s subtle analyses, which I will treat explicitly below. In other words, I do not think Althusser and Popper formulate and address the problem of demarcation in the same way. Paul Patton suggests the opposite when he writes “Thus, from the standpoint of this broader perspective, Althusser’s theoretical tactic of defending Marxism as a science occupies the same theoretical space as Popper’s denunciation of it as a non-science some 30 years ago” (“Althusser’s Epistemology: The Limits of the Theory of Theoretical Practice” Radical Philosophy no. 19 (Spring 1978), 18). More recently, William S. Lewis echoes this claim “Dur-
ing this period [1960-1965], Althusser solved the problem of demarcation by bringing in Marxist philosophy as arbiter” (“Althusser’s Scientism and Aleatory Materialism” Décalages vol. 3 (1), 2016, 11).

18. Pour Marx, 33.
20. It is worth keeping in mind that Engels, in the passage quoted above, is simply stating that a scientist’s knowledge is always necessarily limited to the particular domain a scientist researches, and that outside of that circumscribed scientific domain, every scientist is a “layman”, a “semi-initiate” or “vulgo.” It follows in turn that all scientists will be semi-initiates in other sciences and in philosophy, just as all philosophers will have to become semi-initiates in science. Engels says as much to prepare the reader that he too is going to appear as a lay-person or semi-initiate the discussion of natural science that readers would ostensibly find in Anti-Dühring.
22. Ibid., 33.
23. Ibid., 11-21.
24. Ibid., 24.
25. Ibid., 24.
26. It is worth noting that Althusser calls both epistemological break and problematic “concepts.” His later redefinition of philosophy will require that we refer to them as “categories.” For the sake of this article, I have chosen to call them categories except when quoting Althusser or referring to these direct quotations.
30. Althusser comments at length on this passage in Lire le Capital II, in particular section VI. on “Epistemological Propositions of Capital (Marx. Engels).”
32. Lire le Capital I, 12.
33. Ibid., 28.
36. On this point, see Le rationalisme appliqué and Le matérialisme rationnel.
38. Réponse à John Lewis, 33.
40. In particular two texts with a strange publication history: the untranslated “Matérialisme his-

41. For a full list of scientific revolutions and their corresponding philosophical inheritors see Louis Althusser *Sur la reproduction* (Paris: PUF, 1995), 37-38.

42. “Matérialisme historique et matérielisme dialectique”, 113.

43. Ibid., 114.


49. Ibid., 67.


53. See the final chapter of *Le matérialisme rationnel* for the critique of “continuists”, 207-224.


55. *Le rationalisme appliqué*, 123.

56. *Marxism and epistemology*, 140.


60. *Pour Marx*, 31.


62. In *Lire le Capital I*, we read: “The question we are posing [the question of the cognitive mechanism of appropriation]...is not a question of guarantee” and on the next page “The simple substitution of the question of the mechanism of cognitive appropriation of the real object by means of the object of knowledge for the ideological question of guarantees of the possibility of knowledge contains in itself this mutation of problematic that delivers us from the closed space of ideology, and opens for us the open space of the philosophical theory that we are seeking.” (66-67)


68. Althusser writes in “Sur le travail théorique: difficultés et ressources” (*La Pensée* no. 132, avril 1967) that “Marx’s *Capital* analyzes not a social formation (a real concrete society), but the capital-
First mode of production: we will say it bears on a formal or abstract object” (7).
69. Borrowing from Spinoza, Althusser also finds this same distinction in Marx. Cf. *Lire le Capital I*, 39 sq.
71. I have in mind here Quentin Meillassoux’s claim that Hume is the first correlationist philosopher. For Meillassoux, Hume “inaugurates the properly correlationist form (a sceptical form, in fact) of the ‘correlational circle’: rom the circle, he no longer deduces that all reality is spirit, but that we cannot extract ourselves from the sphere of impressions and ideas, and that the thing in itself must remain irreducibly unknown to us.” (See Meillassoux’s paper “Iteration, Reiteration, Repetition: A Speculative Analysis of the Meaningless Sign” available online: https://cdn.shopify.com/s/files/1/0069/6232/files/Meillassoux_Workshop_Berlin.pdf)
72. Imre Lakatos writes, for example, “Thus the early predictions of Marxism were bold and stunning but they failed. Marxists explained all their failures...the Marxian lagged behind the facts and has been running fast to catch up with them.” (“Science and Pseudo-Science” in *The Methodology of Scientific Research Programmes* ed. John Worrall and Gregory Currie. (Cambridge: Cambridge UP, 1978), 6).
74. In recently published archival texts, Althusser explicitly treats Popper’s theory and agrees on the importance of falsification and experimentation in science, but believes that Popper’s idea of falsification and experimentation are too narrow. Althusser seems to suggest that class struggle is itself a field of possible experimentation and falsification. Not to mention that Althusser’s Spinozism combined with Leninism led him to redefine verification and falsification, which he explains with respect to Lenin’s famous “Marx’s theory is all powerful because it is true.” In “The Althusserian Definition of ‘Theory’” (cited above), Alain Badiou explains Althusser’s anti-pragmatic position, which claims that true theories are not true because they are tested in practice, and in this way, Althusser destroys all dialectical relationship between theory and practice (See in particular page 22). For Althusser’s discussion of Popper and falsification see *Être marxiste en philosophie* (Paris: PUF, 2015) pages 94-97 and *Initiation à la philosophie pour les non-philosophes* (Paris: PUF, 2014) in particular chapter 9 “Scientific practice and idealism”.
77. We read, for example, in Agon Hamza: “…we can say that the very distinction between science and ideology is ideological in itself.” (“Fidelity that is not Interpellation: Reading Althusser’s Misreadings” in *Crisis & Critique: Reading Capital 50 Years Later* vol. 2, no. 2 (2015), 269).
78. Pierre Macherey clarifies this point in detail in “A propos de la rupture” in *La nouvelle critique*, n° 166, mai 1965. He writes, “This is why we cannot say that science replaces ideology, nor that it is preferable to ideology or superior: science is not ‘better’ than ideology, since precisely these two terms cannot be compared” (138).
90. Ibid., 14. Though the term “correct” in English is perhaps a bit clunky, the English expression “to adjust” or “adjustment” nicely captures what Althusser has in mind when he redefines philosophical practice in this way.
91. This is precisely why Alain Badiou’s thought is materialist. It is not because he produces a theory of matter or takes into account material conditions, but because he has drawn out the immense philosophical implications of axiomatic set theory. Infinity, in the current scientific-political conjuncture, is the materialist category *par excellence*.
92. Is this not the position maintained today by most speculative realists? Objects ultimately belong to a strange science-fiction universe wherein their being is irreducible to their primary and secondary qualities, resulting in the inexhaustibility of their essentially mysterious nature. A line of demarcation must be drawn between the work of Quentin Meillassoux, who defends the power of mathematical formalization to exhaust the real, and somebody like Graham Harman, who simply radicalizes Kant to claim that not only can humans not have direct access to the real, but objects cannot even be said to interact with each other directly since they too lack access to the real. Does he not, in expanding Kant in this extreme way, simply apply mechanically to the entire universe the finitude Kant reserved for the human subject? Is this not the most crude anthropomorphism despite Harman’s attempt to produce an *object oriented* philosophy?
93. Knox Peden’s recent treatment of Althusser in his ambitious and thoroughly researched *Spinoza Contra Phenomenology: French Rationalism from Cavaillès to Deleuze* (Stanford: Stanford UP, 2014) insists throughout that Althusser’s commitment to science (rationalism) forecloses any possible political commitment (see page 14-15, 174-17, 262-263 and *passim*). Indeed, this is the thesis of Peden’s entire book. Peden substantiates this claim by quoting Althusser saying “In the same way, it may be said that the science of politics is not political,” but rather than suggesting that science is “neither...determined by the political nor does it have an effect on the political” (174), I take it that Althusser is in fact arguing that science *qua* internal theoretical consistency of its theoretical practice is politically indifferent. In other words, truths *qua* being true are not automatically politically efficacious, but, for Althusser, must be fused with the class struggle of the proletariat. Was it not Spinoza who radically re-thought the Cartesian distinction between true and false to make it such that the sheer presence of truth is not enough to dissolve what is false? And is this not commensurate with Althusser’s thought?
94. *Éléments d’autocritique*, n1, 51-53. “a word...Epistemology. It led us to Bachelard who constantly used the word, and to Canguilhem, who, we did not notice, rarely used the word. We abused it (myself above all) and we did not know how to control it...What do we mean by *Epistemology* Lit-
erally: the theory of the conditions and the forms of scientific practice and its history in different concrete sciences. But this definition can be understood in two senses. In a materialist sense, it could have led us to study the material, social, political, ideological, and philosophical conditions of theoretical ‘modes of production’ and ‘processes of production’ of existing knowledges: but then this would domain would fall under Historical Materialism! And conversely in a speculative sense, Epistemology could have led us to formulate and develop a theory of Scientific Practice [la pratique scientifique] in its difference from other practices: but how is this different from philosophy defined as well as ‘Theory of theoretical practice’? We were this on the terrain of ‘Dialectical Materialism’, since philosophy was, and only was, Epistemology...If Epistemology is philosophy itself, their speculative unity cannot but reinforce theoreticism. But if Epistemology falls under...Historical Materialism, then we must inscribe it therein, and, at the same time, recognize the illusion and imposture of its project. We must (as we have since noted) renounce and criticize idealism and the trace of all Epistemology.”

99. We read for example in “Matérialisme historique et matérialisme dialectique” that Marx’s philosophy is still in the practical state, unlike historical materialism, which Marx was able to elaborate in depth in Capital. “It [Marx’s philosophy] is presented in a still partially ideological form in the great polemical texts of Engels and Lenin. In none of these ‘works’, is Marxist philosophy given to us in a truly adequate and rigorous form.” (98)
100. Louis Althusser “Présentation” of Pierre Macherey’s “La philosophie de la science de Georges Canguilhem: épistémologie et histoire des sciences” in *La pensée* no. 113 (janvier-février 1964): 50-54.
103. *Marxism and epistemology*, 12.
105. Ibid., 173-174.
INTRODUCTION

Interpreters of Bachelard have always been particularly engaged in demonstrating his actuality by insisting on those ideas that point towards a completely new approach and conception of science, and—more importantly—of philosophy and its relation to science. In doing so, they are wont to distinguish between those ideas that are novel and challenging, the marks of a flexible mind adjusting to new times, and those ideas that are atavistic remnants of the philosophical past, or of the present that Bachelard was just then revealing to have become outdated. In the analysis of Bachelard’s reflections of science, the ideas that have been identified as the “actuality” of Bachelard are his conception of discontinuity between the scientific mind and common sense and the material dimension of his conception of science, as exemplified in his concept of phenomenotechnics and of the social nature of knowledge. But the champions of the revolutionary character of these ideas equally stress that Bachelard at times failed to maintain their revolutionary character, which led some to discern a truth behind Bachelard’s philosophy, of which the latter is at times an unfaithful reflection. We see this, for instance, in how Latour and Woolgar or Lecourt respond to Bachelard’s own elaborations of the social nature of science. Latour and Woolgar complain that Bachelard’s “exclusive interest in ‘la coupure épistémologique’ prevented him from undertaking
sociological investigations of science, even though many of his remarks about science make better sense when set within a sociological framework,”. They suggest, in other words, that Bachelard failed to grasp the implications of the social nature of science. Lecourt, on the other hand, shows surprise at Bachelard’s own theoretical elaboration on his conception of the social nature of science, namely as characterized mostly by a split within a single subject that introduces a normative element to his reasoning through internalized intersubjective control. For Lecourt, this seems to be a possible sign of “philosophical bad conscience.” These reactions are but some samples of complaints over the traditional tones to Bachelard’s rationalism.

In this paper, I want to resist these attempts to “actualize” Bachelard, to distinguish between the forward-pointing and the retrograde elements of his thought. In my opinion, the actualization of Bachelard reduces his central ideas to vague inklings, to suggestive and imprecise phrasings of ideas with which later philosophers of science became infatuated. To do so, I will offer an interpretation of Bachelard’s theory of concepts on which, contrary to what his constant insistence on discontinuity, his constant polemic against continuism would suggest, Bachelard leaves much room for continuity in his image of science, and most remarkably, in his image of scientific concepts. More specifically, I will argue that, although Bachelard regards scientific concepts as amenable to historical change, he considers this as a change of the same concept. In order to substantiate this thesis, I will provide an account of Bachelard’s conception of the meaning of a concept, and of what happens to this meaning as a concept changes. In offering such an account, I want to present the actuality of Bachelard, not as a precursor to discontinuist or social-constructivist approaches in the philosophy of science who failed to think through his own ideas, but as an inspiration to current attempts to bridge the gap between different approaches to philosophy of science.

The starting point of my interpretation is one of the traits Bachelard stably describes to the new scientific spirit in The Formation of the Scientific Spirit, The New Scientific Spirit, and The Philosophy of No, and that returns even more explicitly in Applied Rationalism. This repetition reveals that it is eminently important to him, even as he leaves his readers without any truly systematic treatment of it. I believe that a reconstruction of this recurrent idea can help us better understand Bachelard’s theory of conceptualization, and its relation to his mathematicism and his dynamicism, by revealing how Bachelard meant to harmonize these two strands of his thought. He could, of course—or so I will argue—by recognizing that nei-
ther of these positions means quite what we expect them to mean.

The recurrent idea that I want to take as my point of departure is Bachelard’s comments on the relation between comprehension, extension and application of concepts, for instance in a famous and suggestive passage from *The Formation of the Scientific Spirit*:

> In my opinion, the richness of a scientific concept can be measured through its capacity for deformation. This richness cannot be attached to an isolated phenomenon discovered to be richer and richer in characters, richer and richer in comprehension. Even less can this richness be attached to a collection that would gather round the most heteroclite phenomena, that would be extended, in a contingent manner, to new cases. The intermediary nuance would be realized if the enrichment in extension became necessary, as coordinated as the richness in comprehension.4

This passage, which continues with a discussion of the conditions of application of a concept and proceeds to introduce, all too summarily, the concept of a phenomenotechnology, is rich in concepts and notions, and difficult to penetrate. Part of my goal in this paper is to explain how Bachelard views the relation between extension and comprehension, both in the old and in the new scientific spirit. The key to understanding these and other similar passages is a brief and equally enigmatic statement from *Applied Rationalism*: “The extension and the comprehension, far from being inverse the one to the other, as is presented in the problem of classifications, would be, in some way, proportional.”5 Although this comment has not passed unnoticed in the literature, it has not received any systematic treatment either, perhaps because most readers share with Lecourt the idea that “[d]espite the terminology they borrow, these remarks are not the fruit of a study of Formal Logic; they derive from a direct reflection on the structure of scientific discourse.”6 Although this judgment is not wholly erroneous, it does discourage serious attempts to understand what these remarks would mean “logically.” I will argue in this paper that Bachelard’s conception of the relation between the comprehension and the extension of a concept in the new scientific spirit is prompted by the role played by the axiomatic method in the science of his time, and that he is taking notice of important difference between the axiomatic method as it used to be conceived, and the axiomatic method as it is pursued in the new scientific era. In the first section, I will briefly introduce the old image of the axiomatic method, focusing mostly on those features that are at stake in Bachelard’s dis-
Discussion, namely the relation between generality and simplicity, and the role of general logical principles. In the second section, I will give a brief overview of the axiomatic method as envisioned through the Hilbert program, and forming the basis of both revolutions in mathematics and physics, most importantly the emergence of non-Euclidean geometry and non-newtonian mechanics, as well as the lessons Bachelard draws from it. In the third section, I will draw the implications of this picture of axiomatic thought for his view of the system of concepts and conceptualization. In the final section, I suggest a reading of Bachelard’s theory of the meaning of concepts as one that allows them to persist through change and thereby harmonize his insistence on rationalism and progress with a historical and dynamical picture of science many take to imply radical discontinuity.

**THE AXIOMATIC METHOD IN EARLY MODERNITY**

In this first section, I will briefly sketch the main interesting features of the mathematical method in philosophy, and its implication for the conception of a concept, in the Early Modern period, and especially the 18th century. This restriction to the 18th century is not gratuitous: it is inspired by Bachelard’s own interest, in the *Formation of the Scientific Spirit*, in the nature of this spirit in the 18th century. Although the mathematical method was a major source of inspiration for early modern philosophy, there were also major disagreements on its nature, its scope, and its utility. Bachelard’s own position towards mathematics seems to resonate with that of the early modern period. Specifically, Bachelard seems sensitive to the connection between the major epistemological obstacles faced by the eighteenth century, pre-scientific spirit and the “esprit géométrique” of this period.

That respect for mathematics, and in particular for the accomplishment that is Euclid’s *Elements*, was great in both antiquity and modernity, hardly needs reminder. What is important, however, is that the philosophical interpretation of the virtue of mathematics changed substantially. Agreement on the idea that mathematics is the paradigm of real knowledge can obscure intense disagreement on what this means for epistemology. Many Early Modern authors saw themselves as struggling to shake off the yoke of the Aristotelian interpretation of the axiomatic method. For the Aristotelians, at least as read by their early modern critics, the axiomatic method consists of deriving from high-level, highly general principles, principles that either form the basis of the specific science at issue, or are so general that they transcend the boundaries of different sciences, more specific consequences.

The great logical tool for connecting the various levels of this hierarchical system
of principles and concepts is deduction, more specifically the syllogism.

In the early modern period, this picture of the scientific method is attacked from various angles. Most famous and influential are the attacks mounted by Bacon and Descartes. In the Novum Organum, Bacon attacks the deductive, syllogistic method of the Aristotelians, and seeks out a variety of sources of bias that stand in the way of the proper scientific method. A central complaint of Bacon against the Aristotelian method is that the latter jumps all too precipitately to the most general concepts, where these should be formed through extensive empirical inquiry into all the various phenomena that could be relevant to that concept. Bachelard discusses the Baconian method of inquiry in the *Formation of the Scientific Spirit*, for instance in commenting on the example of a call for research on the nature of coagulation by the Académie des Sciences in 1669, commenting that we see there “phenomena of a most diverse, most heteroclite nature, incorporated under the heading: ‘coagulation’.” Bachelard regards this as a clear instance of the Baconian spirit, which he seems to chastise as insufficiently appreciative of the scientific need for theoretical and conceptual guidance.

But Bachelard is not just critical towards the fumbling empiricism he finds in the Baconian tradition. He also attacks the Cartesian doctrine that became the core of what the Early Moderns called the geometric Spirit. The Cartesians agreed with Bacon’s criticism of the Aristotelian idea that high-level generalities are the key to science. They correspondingly criticized the Aristotelian interpretation of the role of the axioms in the geometric method, according to which the solidity of the geometric method stemmed from two sources: the evident nature of the first principles, and the validity of the deductive methods which transferred evidence or certainty from the axioms to the theorems. For Cartesians, the certainty of mathematics was not due to either of these elements: Aristotelians overestimated both the role of first principles and of deductive procedures in the scientific process. According to them, the excellence of mathematics derived largely from the clarity of its concepts. Mathematicians, so Cartesians like Arnauld, Pascal and even Locke argued, were capable of certain knowledge because they made sure that their ideas were sufficiently simple and clear, and that they reasoned only on what they immediately recognized to be evidently true of these ideas and their mutual relations. Far more important than the tissue of principles and deductions is the transparent content of each individual concept. In this way, in early modernity, the superiority of the mathematical method, exemplified in Euclid’s geometry, came to be regarded as due to the simplicity and clarity of the concepts.
used in it, more than due to the logical connections between its axioms, postulates and theorems.

The concepts central to Early Modern science were thought to relate to each other according to a law, namely the law that states that more general concepts are poorer in content, and involve less concepts. Kant formulated the law as follows: “[t]he content and extension of a concept stand in inverse relation to one another. The more a concept contains under itself, namely, the less it contains in itself, and conversely.”¹⁵ This means that a concept’s extension is inversely related to its intension, i.e. the more particulars fall under it, the less concepts are contained in it, and vice versa, which implies that the most general concepts are the most fundamental concepts, and they themselves involve the least concepts.

To illustrate this with a well-known Aristotelian example, namely the relation between the concepts of animal and of human. The intension of such a concept could be interpreted as the list of criteria which an object must satisfy to fall under this concept. Such criteria are themselves the concepts under which an object must jointly fall in order to fall under the concept specified through it. In our Aristotelian example, the intension of the concept of animal would be “sensing living natural being.” This concept has a greater intension than, for instance, that of living being, because the latter contains all the same criteria, but lacks the criterion of sensation. On the other hand, the concept of “human” would have a greater intension, because it contains all the criteria for being an animal, but adds a further criterion, i.e. reason. The more specific a concept, then, the greater its intension. But the same example shows how the extension decreases as the concept becomes more specific, as all humans are animals, but not all animals are humans, i.e. there are more things that are animals than there are things that are humans.¹⁶

Ideally, the fundamental concepts of scientific thought should have no content except for themselves, should be simple and immediately clear. For Bachelard, who frequently refers to the “esprit géométrique,” the formulation of this idea by Pascal is perhaps most significant. According to Bachelard, the latter spirit consists in defining only that which needs definition, and to seek no definition of words that are perfectly simple and perfectly general:

[Geometry] doesn’t define any of the things like space, time, movement, number, equality, nor those many like them, because these terms naturally
denote the things they signify, to those who understand the language, such that the clarification one would make would bring about more confusion than instruction. For nothing is weaker than the discourse of those who wish to define primitive words.17

Pascal himself notes the irony that geometry doesn’t define any of the terms that denote its own principal objects, but regards the perfectly simplicity and transparency of these objects to be the great virtue of this science. The axiomatic method, to early moderns like him, did not mean the deductive science inferring from general principles the content of a science, but was rather characterized by the following main features:

1. The more general and basic a concept, the simpler it is.
2. In science, we should strive to reason on the basis of simple ideas, and hence should seek to reduce complexity to simplicity, in order to ensure precision.
3. In the case of more general concepts of which we do not yet have the content, we should abstain from postulating one, and merely study the broadest possible extension of the concept.

Throughout his works on the New Scientific Spirit, Bachelard seeks to show how more recent developments in the sciences have decisively rejected this procedure in science. In what follows, I will argue that he agrees with the early modern insistence on the implications of the geometric method for the nature of scientific concepts rather than on its deductive method, and that he believes recent evolutions in the axiomatic method also call for changes in our conception of scientific concepts.

THE NEW GEOMETRICAL SPIRIT

The new geometrical Spirit, the new axiomatic method that emerged in the 19th century and became dominant in the early 20th was based partly on a development in geometry, namely the investigations on the parallel postulate. Whereas the old axiomatic method was based on the exemplary role of Euclidean geometry, the new axiomatic method was based on that of non-Euclidean geometry. In this section, I want to argue that Bachelard’s insistence on non-Euclidean geometry in the New Scientific Spirit is due to his appreciation of the new axiomatic method, and that, to him, the new axiomatic method is philosophically relevant because
of what it teaches us about concepts, concept formation and concept application. I will first describe the new axiomatic method, insisting on features that are relevant to my discussion of Bachelard's theory of concepts and conceptualization.

A seminal starting point for the description of the axiomatic method is a lecture by David Hilbert from 1918, titled “Axiomatic Thought.” In this lecture, Hilbert set out to explain the new agenda for science set by the new Axiomatic method. According to Hilbert, any sufficiently advanced field can be axiomatized in the following way:

When we assemble the facts of a definite, more-or-less comprehensive field of knowledge, we soon notice that these facts are capable of being ordered. This ordering always comes about with the help of a certain framework of concepts [Fachwerk von Begriffen] in the following way: a concept of this framework corresponds to each individual object of the field of knowledge, and a logical relation between concepts corresponds to every fact within the field of knowledge. The framework of concepts is nothing other than the theory of the field of knowledge.\footnote{He continues to note that this ordering allows us to recognize certain basic principles underlying the field:}

If we consider a particular theory more closely, we always see that a few distinguished propositions of the field of knowledge underlie the construction of the framework of concepts, and these propositions then suffice by themselves for the construction, in accordance with logical principles, of the entire framework.\footnote{This results in what is likely to be the traditional image of the axiomatic method, namely as method that determines the first principles of a theory or domain and then derives conclusions through mere deduction:}

These fundamental propositions can be regarded from an initial standpoint as the axioms of the individual fields of knowledge: the progressive development of the individual field of knowledge then lies solely in the further logical construction of the already mentioned framework of concepts.\footnote{21}
This seems to suggest that Hilbert regards a science as virtually complete once its foundations have been laid, and the development of that field to be an issue of logical deduction. But this misses an important second aspect of the axiomatic method, which results from the idea that the basis can itself be questioned:

in the cases mentioned above the problem of grounding the individual field of knowledge had found a solution; but this solution was only temporary. In fact, in the individual fields of knowledge the need arose to ground the fundamental axiomatic propositions themselves. So one acquired ‘proofs’ of the linearity of the equation of the plane and the orthogonality of the transformation expressing a movement, of the laws of arithmetical calculation, of the parallelogram of forces, of the Lagrangian equations of motion, of Kirchhoff’s law regarding emission and absorption, of the law of entropy, and of the proposition concerning the existence of roots of an equation.

But critical examination of these ‘proofs’ shows that they are not in themselves proofs, but basically only make it possible to trace things back to certain deeper propositions, which in turn are now to be regarded as new axioms instead of the propositions to be proved. The actual so-called axioms of geometry, arithmetic, statics, mechanics, radiation theory, or thermodynamics arose in this way. These axioms form a layer of axioms which lies deeper than the axiom-layer given by the recently-mentioned fundamental theorems of the individual field of knowledge. The procedure of the axiomatic method, as it is expressed here, amounts to a deepening of the foundations of the individual domains of knowledge—a deepening that is necessary for every edifice that one wishes to expand and to build higher while preserving its stability.\footnote{22}

The progress of the axiomatic method is thus a movement in two directions: one towards the consequences of the axioms, and one towards the foundations of the axioms. Hilbert himself regards the second movement as required for the former. Moreover, his main concern seems to be that of the unity of science, and he regards the deepening as a move towards unification. I suspect he believes that, without ensuring the consistency of two fields by grounding their axioms in a deeper field, the results of the different fields might give rise to contradictions. Hilbert concludes by stating that it is through the axiomatic method that mathematics acquires a leading role in science:
anything at all that can be the object of scientific thought becomes dependent on the axiomatic method, and thereby indirectly on mathematics, as soon as it is ripe for the formation of a theory. By pushing ahead to ever deeper layers of axioms in the sense explained above we also win ever-deeper insights into the essence of scientific thought itself, and we become ever more conscious of the unity of our knowledge. In the sign of the axiomatic method, mathematics is summoned to a leading role in science.\textsuperscript{23}

It would be an error, however, to regard the role of the axiomatic method as solely one of either providing an a priori source of scientific theorems, or a source of unification. Much more important for Hilbert is the two tasks it sets on assessing a system of axioms:

If the theory of a field of knowledge—that is, the framework of concepts that represents it—is to serve its purpose of orienting and ordering, then it must satisfy two requirements above all: \textit{first} it should give us an overview of the \textit{independence} and \textit{dependence} of the propositions of the theory; \textit{second}, it should give us a guarantee of the \textit{consistency} of all the propositions of the theory. In particular, the axioms of each theory are to be examined from these two points of view.\textsuperscript{24}

Together, these two tasks can serve the purpose of clarifying the concepts of this theory by showing how and whether different propositions following from the system are dependent upon each other, and how and whether they are consistent with each other. An important comment Hilbert makes in this context is that “\textit{electrodynamic inertia} and \textit{Einsteinian gravitation} are compatible with the corresponding concepts of the classical theories, since the classical concepts can be conceived as limiting cases of the more general concepts in the new theories”\textsuperscript{25}.

This gives us a more central role of the axiomatic method: the ability to test anew the concepts of a theory by showing how they relate, and whether they in fact contradict certain other concepts, in case we are otherwise badly placed to assess these. These properties are, I believe, central to understanding Bachelard’s own interest in the axiomatic method. Hilbert does not figure centrally in Bachelard’s work, but when he does figure in it, it is as a reminder of the axiomatic method. In the context of a discussion of Gustave Juvet’s work on the relation between the axiomatic method and the recent developments of physics, Bachelard quotes the
famous opening lines of Hilbert’s *Foundations of Geometry*:

Let us consider three distinct systems of things. The things composing the first system, we will call points and designate them by the letters A, B, C, ...; those of the second, we will call straight lines and designate them by the letters a, b, c, ...; and those of the third system, we will call planes and designate them by the Greek letters \( \alpha \), \( \beta \), \( \gamma \), .... The points are called the elements of linear geometry; the points and straight lines, the elements of plane geometry; and the points, lines, and planes, the elements of the geometry of space or the elements of space.\(^{26}\)

What is remarkable about this opening is that it does not start from the notions of points, lines and planes. Rather, it introduces these notions as names of three distinct systems of things. The work than proceeds to characterize these systems through axioms. This is regarded as an effort of abstraction and formalization: an effort is made to think, under these concepts, no more than what is explicitly attributed to them through the axioms, and these axioms are, correspondently, regarded as offering an implicit definition of these concepts. Bachelard comments on the passage as follows:

> All precautions have been taken, then, to ensure that the comprehension of objects is, so to say, a comprehension from above and not from below, as the comprehension of substantial origin was. Stated yet otherwise, these are uniquely relation, and in way substantial qualities.\(^{27}\)

This passage indicates that, for Bachelard, a central feature of the axiomatic method is that it characterizes concepts and objects through their mutual relations, rather than internally. Important for my present purposes is that he describes this as a shift in the notion of comprehension or intension. For the previous conception of a concept, the thing was thought through its comprehension “from below,” for the new axiomatic method, it is thought through its comprehension “from above.” This comprehension from above, the context reveals, is the comprehension as implicit definition through axioms and other such relations.

It is this distinction between two conceptions of comprehension which allows us to understand Bachelard’s otherwise rather enigmatic, and seemingly illogical statement, that in the new scientific spirit, a concept is generalized by adding to its comprehension. I will here briefly present an analysis of the *New Scientific...*
Spirit according to which this “intensional enrichment” comprises two component movements.

Bachelard means to show this through various examples, but I will focus here on his discussion of non-Euclidean geometry and non-Newtonian mechanics. Of non-Euclidean geometry, Bachelard writes the following:

One could say, in a paradoxical manner, that the starting point of non-euclideanism consists in the purification of a pure notion, in the simplification of a simple notion. In fact, [...] one ends up wondering whether the straight line with the parallel doesn’t correspond to a special straight line, to a notion that is too rich, in short, to a notion that is already composite.28

Bachelard is commenting here on the movement through which one realizes that the line as we consider it in Euclidean geometry is not a simple notion, but rather a composite one, and that it is therefore only a special case of the line. If we were to eliminate the special restrictions, we would arrive at a simpler, more general notion, and thereby extend the notion of line to new geometries. This sounds natural enough as a reading, but it also seems to say the exact opposite of what Bachelard seems to hold about the relation between extension and intension in the new scientific spirit, namely that it generalizes through enrichment in comprehension. Here, Bachelard seems to say that in non-Euclidean geometry, we realize that a concept we thought was perfectly general and perfectly simple is, in fact, complex and therefore restricted. Sure enough, the comprehension is enriched in this case, but no extension seems to be won. And the concept of a line is extended beyond the case of Euclidean geometry, but only, it seems, through further simplification. The old law linking intension and extension as inversely related is upheld perfectly.

This initial puzzle, I want to suggest, rests on a confusion, and more precisely a confusion about the shifting meaning of comprehension in the two statements. The above story describes the process of generalization of the concept of a line from the perspective of its comprehension “from below,” namely the internal meaning. In this respect, it is perfectly true that the notion of a line in Euclidean geometry is revealed to contain hidden specifications, and that the removal of these specifications yields a more general concept. But Bachelard also wants us to consider the idea from the perspective of the comprehension “from above”: “the pangeometry eliminates arbitrary presuppositions, or rather she neutralizes them.
by the sole fact that she seeks to offer a complete picture of all presuppositions.” I propose that we read this passage in the following manner: the process of generalization through which the axiomatic method arrived at a more general concept of line, not restricted to the Euclidean case, is indeed one whereby the concept is purified. But this was possible only by increasing the amount of relations to be specified between concepts, and the internal criteria of application for the concept. Only by effacing the need to specify a variety of possible variations along several dimensions could the concept of a line in euclidean geometry be regarded as simple, and it is this simplicity that prohibited its generalization. Ironically then, the higher generality of the concept of a line in geometry is gained through the multiplication of relations between concepts and of parameters to be specified. Bachelard makes a similar point with respect to the concept of mass in non-Newtonian mechanics:

Naturally, [...] it would be all too easy to find the classical mass as a particular case of relativist masses. For this, it would suffice to efface the internal mathematics, to suppress all the theoretical finesse that would yield a complex rationalism. We would find back the simplified reality and the simplified rationalism. Hence, we would deduce, by effacement, Newtonian mechanics from Einsteinian mechanics, without ever being able to make the inverse deduction, in detail or in the whole.

The process of specification to the restricted case is regarded here as a process of effacement of precisely the complexity of theory and of the internal mathematics of a notion. The restricted case is not a product of specification, of complication, but of simplification. This is essential to Bachelard’s philosophy, and reveals that, by comprehension he means the rich structure of the theory as that which delivers meaning, rather than the content of an individual concept. Concepts can be generalized once their solipsism is opened up, i.e. once they are revealed to have a rich content, consisting of all the choices and suppositions made, and all the parameters the values of which were held fixed rather than variable. Here, we find the conceptual holism which other commentators have found in Bachelard. The meaning of a concept reflects the theory in which it is embedded, and grows as its relations within this theory become more elaborate and precise.
From the cases described just now, Bachelard draws a further lesson:

When one makes the balance of knowledge in the system of the 19th century and in that of the 20th, with respect to particular concepts, one must conclude that these concepts have enlarged by becoming more precise and that they can no longer be taken to be simple, except to the extent that one remains content with simplifications. Before, it was imagined that it was through application that concepts became complicated—it was believed that concepts were always applied well or poorly; considered in themselves, they were believed to be simple and pure. In the new thought, the effort of precision is no longer made at the moment of application: it is made at the origin, at the level of principles and concepts.33

Bachelard’s picture of past thought is that there, concepts were thought to be perfectly simple and general in themselves, and that the problem of precision were an issue of application: a concept is immutable and perfectly general. The problem of application is the problem of our relating the concept to reality, of relating its comprehension to its extension. Here, we might be in error, due to the complexity of nature and the finite nature of our capacities. For Bachelard, however, the problem of complexity and precision is proper to concepts themselves. The process through which a concept becomes applicable is that through which it also loses its vagueness, through which it is opened up to reveal the parameters, the compatibilities and incompatibilities, that it hid from sight in its simple or simplified form. This rejoins the crucial passage from the Formation of the Scientific Spirit, which I will repeat and complete:

In my opinion, the richness of a scientific concept can be measured through its capacity for deformation. This richness cannot be attached to an isolated phenomenon discovered to be richer and richer in characters, richer and richer in comprehension. Even less can this richness be attached to a collection that would gather round the most heteroclite phenomena, that would be extended, in a contingent manner, to new cases. The intermediary nuance would be realized if the enrichment in extension became necessary, as coordinated as the richness in comprehension. In order to incorporate new experimental proofs, one ought to deform primitive concepts and study the conditions of application of a concept in the meaning of the
concept itself and should especially incorporate the conditions of application of concept in the meaning of a concept itself.²⁴

We are now in a better position to assess the relation between conditions of application and comprehension. The analyses of the previous sections revealed that, for Bachelard, a concept becomes more general as it is more exactly characterized by explicating the suppositions, the parameters, the conditions laying behind it. Only when subsumed under a rich system of concepts, only when the relations between these concepts become fully specified, can the full extension of the concept be properly assessed. But in this case, it also becomes clear how it is applicable to the situation. The various parameters to be considered in applying the concept are not extraneous to it, are no external complications, but are part of its meaning, in the sense of its comprehension from above.

But the explicitation of meaning in this way has a further important benefit. It reveals possibilities that were unfathomed before. For the Cartesian image of a concept, the modalities regarding this concept were considered to be seen, immediately and clearly, in the concept itself. The possibility of its generalization to another case, the restriction to a specific case, or the applicability to an unconsidered case, were all seen directly as part of the concept. By opening up the concept, but understanding its meaning through its complex relations and the axiomatic system in which it figures, new possibilities are recognized. Two parameters which were previously seen as organically related can now be regarded as independent. More important, assumptions that were previously considered ludicrous now become a possibility. In the case of geometry, this became the suspicion that non-Euclidean geometries might be consistent, and that the concepts of points and lines did not automatically preclude a geometry where the parallel postulate does not hold. But it also suggests important things for physics. In the Philosophy of No, Bachelard describes the case of Dirac’s concept of a negative mass:

For the scientist of the 19th century, the concept of a negative mass would have been a monstrous concept. It would have been a fundamental sign of an error in the theory that would have produced it. [...] It is in this way that the dialectical philosophy of “why not?,” which is characteristic of the new scientific spirit, enters the scene. Why can’t mass be negative? Which essential theoretical modification could legitimate a negative mass? From which experimental perspective would we
be able to discover a negative mass? [...] In short, the theory holds strong, she doesn’t hesitate, at the expense of some modifications at the base, to search for realizations of an entirely new concept, without roots in common reality.35

This passage again contrasts the older conception of a concept, which has a clear inner comprehension, excluding and including certain possibilities necessarily, with the new conception as concerned primarily with a concept’s impossibility from the perspective of the total system of concepts. Here, we see again the axiomatic method, which explicitly asks the question of independence and consistency, and tries to envisage a system in which the assumption of negative mass would turn out coherent. By mathematically elaborating the concept of mass, Dirac uncovered new possibilities, possibilities previously considered ludicrous a priori. One of the core virtues of the new axiomatic method is to create these new possibilities through mathematical analysis.

But this does not just happen through mathematical analysis. Bachelard reveals that the concept of negative mass as a possibility prompts at least two questions, namely:

1. How must our theory be altered such that this concept can be coherent and consistent with the rest of the theory?
2. What would it mean to discover, by means of an experiment, such a negative mass?

The second question, Bachelard immediately proceeds to clarify, is the issue of realization. The new conceptual possibility generates a new concept, and the new scientific spirit is thereby prompted to realize this concept, which is, Bachelard notes “without roots in common reality.”

This is how the axiomatic method also steers research: we are not just dealing with a theoretical exercise, but we are already thinking about a possible experience that would instantiate that theoretical insight. This realization, this possible experience, we all know, must be constructed, by the mediation of theoretically informed instruments, in what he calls phenomenotechnique. What these realize are new possibilities, new concepts, and, since these concepts are thought through their relations, new relations between concepts. In experiments, concepts are pitted against each other, their boundaries and relations are put to the test, put un-
der stress, and this, of course, can happen only if their relations are precise, are explicit. If the concepts remain too vague, if the relations between them remain imprecise, no experiment, no observation can be instructive on them.

This is part of Bachelard’s anti-Baconianism. It is not that we must not strive to take into account the whole extension of a concept, nor that our concepts cannot be informed by our experience. It is rather that it is a precise concept, formulated in advance, which must be put to the test in its extension. And here, the instances are less informative than the constructed case where the boundaries of this concept, its ability to be precisified in these different contexts, and its precise relations and differences with other conferences, become realized.

But Bachelard warns us that it is a mistake to think of the phase of theoretical reflection and that of theory testing as two-distinct phases. If one does so, one is considering theoretical reflection in science as abstract reasoning in which one (largely qualitatively) appreciates the implications of one’s theory, and only later devises a method to test the truth of a hypothesis. In such an attempt, the precisification and the conditions of application of a concept are relevant only when one proceeds to the testing phase. For Bachelard, such a view misunderstands both the fruitful role of experimentation in concept-formation, and the productive role of mathematics in theorizing. In his view, new theoretical vistas can be reached only through mathematical precision, and the latter is always partly motivated by questions concerning experimental set-up and measurement.

This reveals that, for all his talk of instruments, technology and practice, Bachelard’s philosophy remains a philosophy of concepts, or more precisely of concepts and their relations. Concepts, however, cease to be pre-given, individual entities, but become rather nodes in a structural network of relations, determining possibilities, and conditions of application. Shifts in these relations, unsuspected possibilities, prompt further experimentation, which is the attempt to instantiate a possibility, to put to the test, not a theory, but a relation between concepts, and perhaps most importantly, to test the capacity for deformation of concepts.

CONCEPT FORMATION AND CONCEPT DEFORMATION

In the passage of the *Formation of the Scientific Spirit* on which this paper is ultimately a long commentary, Bachelard uses the notion of deformation twice to characterize what happens to scientific concepts. I want to finish with a sugges-
tion on how to read this idea, and what it serves to reveal. The puzzle offered by Bachelard’s philosophy, and by similar philosophies insisting on both the structural, holistic nature of systems of concepts and historical change, is that they incur challenges in explaining the continuity of concepts. In itself, this might be thought unimportant for those interested in the historical discontinuities characterizing science. Read from this perspective, Bachelard does not have a problem: he can simply insist that, underlying the stability of the term, the concept, e.g. of “mass” or of “line” has changed irrevocably, such that it is no longer the same concept. The stability of the term perhaps fools some philosophers, who fail to pay close attention to the development of the sciences, that the same concept is at stake, whereas in fact we are now in an incommensurable system of concepts, where the original term takes on a completely new meaning.

But this does not seem to be what Bachelard imagines as the progress of science. Sure, the scientific spirit itself is marked by discontinuities, and methods can be valid in one historical phase and invalid in the next. But this does not mean that the system of concepts succeed one another discontinuously. This is already suggested by Bachelard’s own statements on how earlier sciences relate to later, how Euclidean geometry relates to the pangeometry of the new era, how Newtonian mechanics relate to Einsteinian mechanics:

The generalization by the no ought to include what it denies. In fact, the whole spring of scientific thought for the past century stems from such dialectical generalizations with the envelopment of what they deny. In this way, non-Euclidean geometry envelops Euclidean geometry, non-Newtonian mechanics envelops Newtonian mechanics: wave mechanics envelops relativist mechanics.56

For Bachelard to be able to say this, some relation between two historical phases of the same concepts must be maintained, such that we can reasonably say that it is still the same concept. This should not be a surprising result, since Bachelard insists time and time again on the historicity of concepts, and a concept could not have a history if it can only be replaced. We should take the language of generalization more at face value: for a concept to become generalized, it is necessary that it be opened, that it become more complex, that it reveal its relations to other concepts, its precise conditions of applications. It is not the case that one concept is replaced by another, that a concept changes if its comprehension, i.e. its meaning changes. Again, in the crucial pages of the Formation of the Scientific
Scientific conceptualization requires a series of concepts on its way to be perfected in order to receive the dynamism that I’m aiming for, in order to form an axis of inventive thoughts.

This conceptualization totalizes and actualizes the history of a concept. Beyond history, pushed by history, it solicits experiments in order to deform a historical stage of the concept. In experiment, it seeks occasions to *complicate* the concept, to *apply* it in spite of the resistance of this concept, in order to realize the conditions of application that reality never brings together.\(^{37}\)

This famously historicist and developmental picture of science is a picture of conceptualization. Conceptualization is continuous process whereby the different historical stages of a concept are deformed, or rather, are prompted to be deformed by complication *cum* application, and the concept at any historical stage is marked by the history of these deformations. A concept is a fruitful scientific concept, engaged in an axiological axis, to the extent that it can be transformed in spite of its resistance.

I am tempted to expand here on an inkling of Canguilhem’s namely that, when Bachelard finally seeks to characterize the broad image of his historicist structuralism, he does so in unmistakably biological terms, such as mutation, \(\text{\`el\`an} \ \text{vital}\), etc...\(^{38}\) And indeed, it is difficult to overlook the peculiar image of a concept in Bachelard, which somehow, in spite of itself, prompts its own deformation, and shows its use and longevity in its ability to overcome these challenges through successful deformation. A good concept overcomes its earlier, vague, imaginative, intuitive content, but does so because of the virtues of that content, virtues in its capacity to prompt and undergo deformation. A Bachelardian concept is valued in the same way as a Canguilhemian organism: by its capacity to overcome its current norms, but its capacity to adapt, to create a new norm for itself, by its plasticity and capacity to deformation in order to remain alive. Like a Canguilhemian organism, a Bachelardian concept is one that persists to the extent that it can balance its robustness with its adaptiveness, such that the latter is always not just in spite of, but also for the sake of the former.

As Ferdinand Gonseth, philosophical fellow traveler to Bachelard, once wrote: “a living concept cannot be created at once by a merely verbal definition, but
emerges from its past and is modified by its use.” Gonseth stresses the notion of “living,” seemingly aware of the organic connotations of the properties he is ascribing to a concept, and thereby, once again, resonating with Bachelard’s metaphors. These metaphors, then, are not superficial, but instead express something essential about the theory of conceptualization we find in these authors. It could be worth it to prompt these concepts, and their as yet but metaphorical imagery, to become more precise, and to be deformed. One way to do so may be through a different interpretation of the meaning of an axiom. Gonseth, after all, continued the passage I just quoted with the following remark:

Of the extent to which a word can veer away from its original sense bit by bit, the extent to which the concept that it covers can vary by imperceptible degrees and at times by sudden jumps, the word axiom is right now a striking example.†

I believe the word axiom is a striking example precisely because it evolved from the concept of that which stipulates, for now until eternity, the meanings and interactions of concepts, to a concept that is at the heart of a dynamical picture of concepts and conceptualization. As I remarked in the second section of this paper, Hilbert thought of the axiomatic method as comprised of two movements: one that deduces results from the basis axioms in the old style, and one that deepens the basis by seeking to unify and generalize. In this paper, I have sought to show that Bachelard saw the potential of the second movement as one of the motors of the process of conceptualization. It is this process which opens up concepts, articulates their simple states by increasing their relations with each other, by interdefining them to a greater and greater extent. But I have also wanted to suggest that the process of conceptualization is therefore also the process whereby concepts persist through scientific change by changing in this way. This is not a paradox, as Bachelard admitted in his early *Essai sur la connaissance approchée* that concepts are marked by plasticity:

There are in the life of the mind moments that leave indelible traces, elements that nothing, it seems, could rectify: such are concepts. Of course, certain concepts that reveal themselves to be perfectly inadequate can disappear altogether, but they cannot fold to express as yet an experience that no longer supports them.

But these solidly fixed elements present themselves at the summit of the process of conceptualization. If we could penetrate into the dust
of minor concepts that spring immediately from sensation, we would see their fundamental plastic character.\footnote{Bachelard rejects the idea that concepts are fixed, and thereby also rejects the idea that they either persist unchanged or disappear altogether. This idea that concepts need to remain fixed to persist is the fundamental idea that lies behind both anti-historical perspectives and historical perspectives that insist on relativism and incommensurability: any change in the meaning of the concept would imply that we are, in fact, dealing with another concept.\footnote{To Bachelard, this is wrong: concepts are dynamical in nature, and can persist through change. It is this very plasticity that can allow them to persist while theories, paradigms, epistememes, etc. change around them. Of course, some die out, some fail to persist, but those that do, do so not just because they have overcome the obstacles thrown at them by recalcitrant experience or theoretical change, but rather because they pre-empted the latter by their internal impulse for complication, and have overcome the internal obstacles that lead them to avoid deformation, all while maintaining enough of their identity. The new scientific spirit, for Bachelard, is one that recognizes this change and participates in the elaboration of concepts. Such a dynamic picture of concepts can maintain continuity and rationality in the face of historicity.}

That Bachelard’s philosophy is, in this manner, a philosophy of concepts, does not mean that he ultimately falls prey to the atavistic positivism that is often criticized in his name. This judgment is based on the idea that all aspects of such a theory are ultimately hazardous to understanding discontinuity, technology and the social in science. Rather, Bachelard’s specific way to focus on concepts may help overcome some of the tensions to which attention to discontinuity, technology and the social have given rise. For one, Hans Radder has expressed concern over the tendency among some philosophers of experiment to regard concepts as local to experiments, and suggests that the non-locality of theoretical concepts is what allows them to have “unintended consequences’ that might arise from their potential use in novel situations”\footnote{Bachelard’s philosophy of concepts as persisting through deformation and suggesting unsuspected possibilities might be crucial to understanding how, for him, experiment has an “instructive” role in science. Secondly, this picture of Bachelard’s philosophy of concepts might aid in some of the problems his discontinuist picture raises for the dialogue between history of science and philosophy of science, as has been recognized by Christina Chimisso: the new axiomatic method · 227}.
Bachelard’s view of history of science [...] seems to leave little space for narratives that are not those ‘sanctioned’ by current science and that link present science with lapsed doctrines. It also interdicts long narratives, as science for Bachelard has only begun at the end of the eighteenth-century.\textsuperscript{44}

On my interpretation, Bachelard ultimately allows for some continuity between the different deformations of the same concept, and ascribes to conceptual reflection some transformative role in science. In this way, his picture allows for a more positive role of history of science in philosophy of science than one would expect. The actuality of Bachelard thereby seems to consist in the opportunity he allowed for a philosophy of science that pays equal attention to all dimensions of science and integrates the various approaches to the sciences in a relation that he might have preferred to call dialectical.
NOTES


11. Bachelard is in all likelihood thinking of the equally heteroclite—to the modern eye—“table of essence and presence” of heat to be found at Bacon, *Instauratio Magna*, pp. 127-129, as the main source of inspiration for such assortments of phenomena.


16. In later developments in the history of logic, the validity of law has been called into question, of course (see for instance Clarence Irving Lewis (1918). *A Survey of Symbolic Logic*. Berkeley: University of California Press, p.322.

17. Pascal, *De l'esprit géométrique*, pp. 473-474.


28. Bachelard, nouvel Esprit, p. 27.
32. The role of late 19th century developments in mathematics and theoretical physics and their implications for the nature of concepts and for epistemological change figure in a similar way in Ernst Cassirer (1910) Substanzbegriff und Funktionsbegriff. Berlin: Bruno Cassirer Verlag. Both philosophers insist that the meaning of the basic of concepts of science change to more relational and functional and less “substantial.” I am not sure whether this is due to a direct influence, and suspect rather that the influence of Brunschvicg on Bachelard made the latter sensitive to neo-Kantian ideas. In fact, there is a way in which Bachelard’s approach, with its insistence on a productive role for the a priori, is still a neo-Kantian approach, and Bachelard himself admits that his non-kantism is not a rejection, but rather a rectification of Kant, in the same way in which the Marburger Schule considered itself to be a rectification of Kant informed by the development of science.
33. Bachelard, nouvel Esprit, p. 52.
34. Bachelard, Formation, p. 74.
37. Bachelard, Formation, pp. 74-75.
40. Gonseth, mathématiques et réalité, p. 236.
42. A more subtle version of this view, which can be discerned in Dominique Lecourt’s work (cf. Lecourt, Marxism and Epistemology, pp. 84-86), is that the continuity is as it were retroactive: a new stage of science establishes retroactive continuity by projecting its own knowledge into the past, and assimilating its earlier stage into the former. Although one could reconstruct passages such as those on the relation between Euclidean and non-Euclidean geometry in this fashion, Stephen Gaukroger was right to insist that this does not square with all of Bachelard’s comments on the persistence of concepts (cf. Stephen Gaukroger (1976). “Bachelard and the Problem of Epistemological Analysis.” Studies in the history and Philosophy of Science 7(3), p. 234.). Of course,
Lecourt could regard these passages as atavistic but inessential, where Gaukroger regards them as essential and revealing of a central flaw. In this paper, I have attempted to offer a different appreciation, and regard this as Bachelard’s actuality.


Xenofeminism is a “feminism frustrated with the need for its existence.” With regards to other feminisms, it is a scavenger. It strips for parts, reassembles, takes what it wants, hacks and reorients. It wants to develop a symbiotic or parasitic relation to already existing technologies (including those of thought). One of the timely passages from the manifesto,

...the excess of modesty in feminist agendas of recent decades is not proportionate to the monstrous complexity of our reality, a reality crosshatched with fibre-optic cables, radio and microwaves, oil and gas pipelines, aerial and shipping routes, and the unrelenting, simultaneous execution of millions of communication protocols with every passing millisecond...

alludes to xenofeminism’s willingness to deal with problems inherent to digital culture or global complexity and trespass where, it claims, feminist theory might not dare. Xenofeminism sees the rising wave of technocracy but instead of searching for a buoy, it wants to catch the surf. It wants “superior forms of corruption.” Its hands and souls are not pure but synthetic. Its body is not made in the Garden of Eden but continually engineered in accordance with available tools. There is nothing, it claims, “that cannot be studied scientifically and manipulated technologically.”
In my encounters with people interested in the manifesto, from scholars of philosophy and politicians to crypto-inclined artists and post-witchcraft feminists frustrated with the commodification of their once-revolutionary pursuits, it became apparent that it was a versatile beast. It produced widely incompatible interpretations. Some admired its disavowal of redemptive identity politics and of transphobia, some were interested in the aesthetics of accelerationism, others in cyberfeminist legacy. All, however, were drawn to xenofeminism’s explicit alliance with reason, artifice, technology, and science: “our lot is cast with technoscience, where nothing is so sacred that it cannot be re-engineered.” For mainstream feminist theory, dominated by postmodern and poststructural philosophy, statements such as “emancipatory tactics can be scaled up for universal implementation” or “science is not an expression but a suspension of gender” are heresies. More so, against feminist luddites, xenofeminism embraces the artificial and desires to drive a stake through the heart of ecofeminist affirmations of women as caring parental and environmental protectors.

“The Xenofeminist Manifesto,” first released online by Laboria Cuboniks in 2015 and later printed by Verso was a polemic and a provocation, borne out of furious paragraph assembling in a collectively-edited Google doc. If some hands were more crafty than others in this labor, we can only tell it by studying the solo work of its authors, picking and guessing, recognizing overlapping thematic or stylistic concerns across publications. This, however, would be to the displeasure of the collective, which asserted in the manifesto that Laboria Cuboniks is a blueprint for an open source software, “a mutable architecture,” a platform. For those who wanted to engage in an annotated polemic, this presented a dilemma: how can we debate with a faceless manifesto that changes its directions with ease, like colored blocks on a Rubik’s cube? Manifestos are slippery, incoherent. As Lucca Fraser of Laboria Cuboniks said, manifestos are like “stand up comedy...their job is to point things out . . . [t]o nudge you into adopting a point of view that might not have seemed available beforehand.”

The initial commitment to anonymity was a tip of the hat to cyberfeminism. In the early days of our omnivorous cyberswamp the possibility of erasing and collectivising ourselves on anonymous networks was quite the narrative. The manifesto’s cyberpunk 90s online aesthetics allude in particular to VNS Matrix, the legendary “terminators of the moral code, mercenaries of slime...saboteurs of big daddy mainframe.” But anonymity is hard to preserve these days. Soon enough, faces were put to sentences and it became more difficult to not see the manifesto

helen hester, xenofeminism · 233
Collectives are intriguing and one could easily imagine a Laboria Cuboniks profile in *The New Yorker*, where it would be presumed that the key to the text always lies in its authors’ biographies. Character traits could be played up until we end up with a fraudulent but catchy cast of six xenofeminists in our remake of Jeff VanderMeer’s *Annihilation*: the cyberwitch, the academic, the hacker, the engineer, the artist, the sociologist. This would be a fool’s errand for each of them is all six at once. And yet, for scholars of xenofeminism, stalker impulse cannot be easily overcome, mostly because each postulate in the manifesto becomes clearer for knowing the solo work of its writers. Digging around, one could even suspect that the group’s name, an anagram of Nicolas Bourbaki, a collective of mathematicians that devoted themselves to rigorous abstraction, was the brainchild of Burch who performs under the name Yonda Lemma, a term also borrowed from mathematics, which describes the embedding of a local category into a set of functions as morphisms.

While not all members of Laboria Cuboniks led research clusters at that fateful summer school, the two that did already signaled what was to become crucial for the manifesto. Fraser listed her topics as “universality as intersectionality” and “intersectionality and genericity,” while Hester’s were “feminism and technology after [Shulamith] Firestone” and “re-engineering embodiment.” How could it be, xenofeminism asks, that contemporary feminism can accept the systemic nature of a totality called capitalism while at the same time championing “local, fragmented, or partial” solutions? Hester summarizes the problem well by citing an intersecting analysis:

Nancy Fraser, too, has addressed this apparent “shrinking of emancipatory vision at the fin de siècle,” linking this with “a major shift in the feminist imaginary” during the 1980s and 1990s—that is, with a move away from attempting to remake political economy (redistribution) and towards an effort at transforming culture (recognition).
Rather than participating in the game of representations, xenofeminism wants to focus on seizing material tools, technologies with which to re-engineer biology and society. While it might recognize the strategic benefit of identities, it maintains its commitment to shedding them in the future, like a snake sheds its skin. Xeno, after all, means strange, alien, unfamiliar. It would be correct to think of xenofeminism as a xenomorph. As a tool, xenofeminism is a way of admitting that we are already inside a giant technological accelerator and we need to keep adjusting accordingly. This calls for strategic flexibility: no-body is sacred and the future might demand bio-engineering ourselves beyond current species limitations. After all, the manifesto asserts that we “[live in] a world that swarms with technological mediation, interlacing our daily lives with abstraction, virtuality, and complexity.” We are all jacked into a planetary machine that continually speeds up, the question is, which sockets do we plug into? If xenofeminism is a platform, a program, a protocol, a tool that can be grasped across its different iterations, it is united by the desire to write the outside in, to undermine what appears natural and therefore lend itself to continued context-dependent use of technology.

In the manifesto, the concepts of nature and alienation work in tandem—one is discouraged and the other one is applauded. Two of the earliest academic publications assessing this rhetoric, by Emma Wilson and myself respectively, were very much critical of how the concept of ‘nature’ was used—Wilson showed that biologist and feminist scholar of technology Donna Haraway contributed to resolving the false binary of technology and nature, while I pointed out that xenofeminism’s desire to overcome ‘nature’ is undermined by its disregard for decolonial and anthropological scholarship as well as its unawareness of advances made in the field of animal studies. Because of this omission, the vilified ‘nature’ becomes little more than a strawman, an aestheticised choice of machine over flesh that is only valid on terms of its own misdefinition of ‘nature’ as separate from technology.

One of its most daring propositions, that “alienation is the labor of freedom’s construction,” seems to allude to Marxism but disappointingly turns out to be a stylistic choice, an interesting way of saying ‘embrace technology, refuse nature (the given),’ rather than an attempt to challenge Marx assessment of ‘alienation’ as an oppressive axiom of capitalism. In xenofeminism, alienation means siding with the artificial, ‘unnatural’ and unfamiliar as well as refusing the use of ‘nature’ to justify wholly ‘social’ configurations such as the ‘natural’ predisposition of women to motherhood or care. This position ostensibly goes directly against the early ecofeminist dogma that womanhood (1) is defined by its proximity to nature.
and (2) is therefore predisposed as separate from technology. In a previous article, I protested that by this logic, both xenofeminism and ecofeminism perpetuate the nature/technology split, while in fact it would be more correct to say that nature grasped properly is technology and technology grasped properly is nature. To further summarise my previous criticism, while ecofeminism hailing from the 1990s is indeed guilty of essentialism and naïve fetishisation of ‘nature,’ fetishising ‘artifice’ and ‘technology’ does little to amend the problem. Decolonial and new materialist feminist scholarship today works hard to conquer these dogmas, often amending the problems of early ecofeminism and frankly providing a more nuanced approach to the relation between nature and culture than xenofeminism does in the manifesto.12

With this specific definition of alienation in mind, embracing alienation and artifice is a common thread running through the manifesto, which proclaims that “the real emancipatory potential of technology remains unrealized,” opening up to speculative design. Like Cypher in the infamous steak-savoring scene, xenofeminism not only stays in the Matrix but wants to be its architects. This, for Burch and Reed, translates into doing away with the human as an unremarkable given. Burch has recently written about ‘xenolistening’ and ‘xenotemporality,’ her term for the increasingly common idea that the anthropogenic perception of time has to open up towards scales beyond humans’ perceptual capacities:

We would like to recode machinic blasts from the future, decaying some-place else. Could be—a science fiction—leaking of sound into the skin, cannibalized hard, core soaked, bled from pixel-seasoned flesh. Navigational schemes are hitched by the xenotype... The coming techno-sapiens’ living body never listens alone. It traverses cosmically low. And wide enough, to pulse in flowering nonhuman drones, and to array purple-shifting antibodies for transcendental immanence.13

Reed similarly appreciates the unfamiliar. She writes, “alienation is a necessary force of estrangement from what is.” This can point us to the yet unarticulated genealogies of xenofeminism, for example in the work of Wendy Chun or Luciana Parisi. Reed recalls Chun’s observation that algorithms are often structured through “homophily in network design,” an “automation of familiarity” that creates self-replicating ‘echo chambers’ and where coming into contact with the alien is written out of the algorithm itself. “Xenophily,” as she explains, is a proposition for an infrastructure of machinic intelligence that would write the alien in.14 In
calling for “commitments [both to and] beyond our species” as a principle that should guide both automation and speculative design in the climate change era, Bauer explicitly relates such inquiries to justice. Fraser, who works on a variety of theoretical and practical projects, sees in xenofeminism a rejuvenation of cyberfeminism but this time able to both respond to and design artificial intelligence or emancipatory online spaces. In critical dialogue with the works of Firestone, Sarah Kember, Alison Adam and Nick Land, Fraser understands xenofeminism as a project continuous with the Enlightenment, where the mastery of ‘nature’ would lead not only to the abolition of sex but to “the emancipation of intelligence.”

Hester and Ireland have most explicitly taken up the problem of xenofemininity. In an unofficial capacity a historian of the Cybernetic Cultures Research Unit, Ireland also remains its most visible heir through the focus on the continuity between femininity and alienated, inhuman virtuality. It is useful to keep her take on this matter in mind as we move through Hester’s book. “We are used to calls to resist the total integration of our world into the machinations of the spectacle,” Ireland says in an interview, “to throw off the alienated state that capitalism has bequeathed to us and return to more authentic processes, often marked as an original human symbiosis with nature.” She prefers to throw her lot in with the bots, her methodology akin to that of Tetsuo, the Iron Man, the extreme Japanese horror film in which the union between man and machine is literal: “I feed myself to machines.”

Following from Sadie Plant’s reading of Luce Irigaray, Ireland affirms occult operations within the formless, commodified, inhuman bodies of women. Future intelligence will arrive as a thing, she says, and only things can understand things—by turning women into things, patriarchy makes women’s alliance with machines easy, against its own interest. That womanhood is already a spectacle or an ‘unnatural’ simulation without origin is the woman’s gain, not her curse: “Because she is continuous with [the spectacle], she is imperceptible within it.” This weaponisation of imperceptibility is what aligns women to demons to machines, all excluded from the economy of the Phallus on the shiny side of the screen. Like other members of the collective, Ireland argues against the repetition of the same, the homeostasis of heteronormativity, in favor of ‘the replicant’: “woman plus man produces homeostasis (the equilibrium of inequality), but woman plus woman, or woman plus machine, recalibrates the productive drive,” eventually pushing it over the edge and into something else, something inhuman, a glitch on the smooth reproduction of the same.
women and the machines, both contribute to the literal erosion of sexed identities. Artifice is a powerful weapon. Trans women will birth AI daughters.20

With these congruent takes in mind, while Helen Hester’s recently published book is titled Xenofeminism it would be a mistake to think that it exhausts the subject. For those interested in xenofeminist takes on digital economy, artificial intelligence, modern warfare, or climate change, it will be disappointing that, while the manifesto claims that xenofeminism is “a feminism of unprecedented cunning, scale, and vision,” Hester’s book is only a skilled update of existing Anglophone queer and feminist theories interested in domestic, ‘small,’ mundane technologies and acts of care, which with time may translate bodily autonomy into scalable political change. ‘Repurposing’ is for Hester a key methodology; it describes not only her self-professed DIY approach to technology but also her method of engaging with existing feminist oeuvre. This can hardly be levelled as a criticism of the book, which is transparent about its scope and written with considerable care and intelligence. As an academic work, it also provides a bibliography, showing us a part of xenofeminism’s genealogy. While it works well as an origin story, the more daring elements of the manifesto that seemed to have attracted most attention and were visibly diverging from feminist theories in the modern academia are not addressed in Hester’s book, including the influence that neorationalism, left and right accelerationism and contemporary technologies had on xenofeminism. Instead, Hester uses the monograph to build bridges between various existing strands of feminism, re-activating and updating well-known feminist propositions of bodily autonomy.

In the introduction, Hester briefly mentions xenofeminism’s varied genealogy—“cyberfeminism, posthumanism, accelerationism, neorationalism, materialist feminism and so on” (1)—but her contribution has a particular lineage, informed by her expertise in trans, queer and feminist studies as well as Marxism (which in the book is implied rather than explicit). The slim volume focuses on one issue in particular: the relation between social and biological reproduction, a largely unwaged labor of reproducing both the species and the fabric of society that has been historically assigned to women. Women are not separate from technology but are already frequently used as sexual and/or reproductive technologies. Xenofeminism asks whether a technology can hack itself to begin reproducing something alien on a mass scale. For Hester, this means reclaiming some of the legacies of feminist post-structuralism, which teaches us that what presents itself as ‘natural’ is indistinguishable from social norms. Notably, Hester sees in xeno-
feminism and in its embrace of ‘artifice’ a way of invalidating the claims of trans-exclusionary radical feminism in which the correlation between ‘nature,’ ‘women’ and ‘goodness’ is particularly visible.

In this context, Hester names the three pillars of xenofeminism: technomaterialism, anti-naturalism and gender abolitionism (6). The book is divided into three sections, all of which focus on re-engineering social and sexual reproduction. In “What is Xenofeminism?,” her chief interlocutors are Shulamith Firestone and eco-feminist thinkers like Vandana Shiva and Maria Mies. Here, Hester challenges normative uses of ‘nature’ and instead proposes a synthetic or technologized understanding of womanhood, which accommodates both trans and cis women. In “Xenofeminist Futurities,” her main references are Haraway and queer theorist Lee Edelman, who have been vocal on the issues of non-reproductive futures. If read literally, this can mean direct discouragement of having babies. Through an attentive close reading, Hester puts forth a proposition for a futurity that does not loop itself in the boring, oppressive repetition of the daddy-mommy-me family structure while also being hospitable to actual parents and children. As much as the first two resemble a literature review, “Xenofeminist Technologies” is an extended case study chapter of Del-Em, a menstrual extraction tool designed by American feminists in the 1970s. This surgical device allowed one to pass the entire menses at once and doubled as an early abortion technique. While the project was short-lived, Hester uses it as an example of proto-xenofeminist tech.

Each chapter, in its own way, declares a war on ‘nature,’ a strategy shared with the manifesto. Hester’s book deals mostly with how things are constructed as natural or are made to appear natural, although she also considers a future in which currently biologically sexed states such as pregnancy could be technologically mutated. I have previously argued that xenofeminism fails to define what it considers as ‘nature’ and thus perpetuates the modernist split between nature and technology. For Hester, ‘nature’ chiefly means ‘natural womanhood,’ or simply ‘the normative,’ as in what appears ‘given’ and thus naturalised or accepted as if it was natural. This is not only hardly novel but also quite confusing. What is meant here by ‘nature’ is a cultural construct of what ‘nature’ is, a question that feminism occupied itself with since its academic inception, and particularly with Judith Butler to new materialism, post-humanism or even philosophers like Catherine Malabou. As Hester herself mentions by referring to the work of Elizabeth Wilson, biology itself is neither binary nor normative (21). To the contrary, biology grasped scientifically is strange and unfamiliar and does not obey human
gender binaries. From that standpoint, xenofeminism is natural and it is patriarchy that is artificial. What only appears natural changes frequently over time; the normative is a more widely-applicable word albeit with less dramatic and stylistic potential. When Hester writes that “xenofeminism is invested in constructing an alien future,” she really means confronting what is normative, not natural, that is the heterosexual social matrix (33). Sympathetic as we may be to the xenofeminist project, in the Anthropocene, defining ‘nature’ as ‘the normative’ is a lot to ask. Unlike the normative, nature, understood as the field of science, cannot be just or unjust, nature does not care, regardless of whether humans place ethical judgments in its name. Hester already knows this; as she writes in a recent essay, “[Xenofeminism] privilege[s] the synthetic over the organic, the mediated over the immediate, and technologized natureculture over an inflated idea of “the natural” but this consideration has not quite made it into the book.” Flawed as it is, the slogan of “changing nature” nevertheless groups potent imageries together and lets xenofeminism address both the normative and some of the current limitations of biology.

Xenofeminism, a feminism frustrated with the necessity of its existence, longs to automate itself, to be the mechanism by which women write themselves out of the labor of having to continually reproduce feminism. I titled this review “Automate the Womb” to allude to Hester’s focus on challenging naturalised patterns of social and sexual reproduction and re-engineering the structures of women’s labor, from bodies to homes and workplaces. This title also refers to Hester’s and Laboria Cuboniks’ desire to nip in the bud trans-exclusionary feminism: nothing about women’s bodies, and especially the romanticised space of gestation, is so sacred that it cannot be re-engineered. Automating bodies is about freeing us from limitations and breaking whatever connection they might have to the ideal of ‘womanhood,’ while remaining vigilant in materialist analyses of how the diversity of bodies that women inhabit provoke various types of oppression. In the remainder of this essay, I will review Hester’s book and contextualise it by relating it to the arguments she advances in her other published work and to the Xenofeminist Manifesto.

NOTHING ‘NATURAL’: WHAT IS XENOFEMINISM?

Nothing should be accepted as fixed, permanent, or ‘given’... anyone who has been deemed ‘unnatural’ in the face of reigning biological norms, anyone’s who’s experienced injustice wrought in the name of natural order, will realize that the
glorification of ‘nature’ has nothing to offer us—the queer and trans among us, the differently-abled, as well as those who have suffered discrimination due to pregnancy or duties connected to child-rearing.

Xenofeminist Manifesto

“In the name of feminism, ‘Nature’ shall no longer be a refuge of injustice, or a basis for any political justification whatsoever! If nature is unjust, change nature!” These lines spell the closing sentences of the manifesto. But what does nature mean here? Is changing nature about free access to hormones or geoengineering? Is it about breeding animals for human organ transplants? Is it about Monsanto crops, industrial farming and climate change? Is it about biology or health? Or maybe about developing ectogenesis chambers for all mammals? How can nature be just or unjust at all? Is that not a purely theological question? While the manifesto promises riches, enthusiastically naming perplexing technological complexity as its goal of study and reform, Hester is interested in a much more common feminist theme: ‘nature’ as a code word for essentialist gender identity.

There are two general ways to think about identity: destructive or restorative. The first is the idea that as subjects we should struggle against identities and recognize how they are constructed. While identity markers might serve us well in finding one another or even developing political projects, “[in the longer term] the full range of these traits should be stripped of their social significance, and therefore of their ability to act as vectors of discrimination” (29). This is a balancing act because patriarchy also calls for removing identity from consideration. The patriarchal project, however, is strongly irrational and subjective, for the only gendered characteristics it wants to abolish are those that it simultaneously constructs as ‘female.’ When patriarchy calls for the abolition of gender, what it means is the exclusion of those whom it perceives as women or ‘womanly.’ When the manifesto calls for the abolition of gender, it calls for a genuinely abolitionist project carried out through to the end, where gender becomes a meaningless designation and therefore identitarian “characteristics are no more a basis of discrimination than the color of one’s eyes,” as the manifesto puts it.

While Hester recognizes the importance of exposing gendered histories, in which women are ‘naturally’ predisposed to something, at the moment when “a recognition of historical gender roles tips into an apparent naturalization of these roles is the point at which this approach loses its xenofeminist efficacy” (37) and tilts towards the politics of restorative or redemptive identity. This approach posits that
there exists an ‘innate’ identity—there is something ‘natural’ to how gender is organised, which is tweaked and perverted, and therefore has to be restored. One way to understand this is through the quarrel that Hester has with the version of ecofeminism advocated by Vandana Shiva and Maria Mies, who criticise science, technology and patriarchy as ways of manipulating or intervening into nature (17), and defined women as naturally caring “environmental guardians attributed to their connection with practices such as familial care, subsistence farming, and social reproduction” (37). The manifesto minces no words about such ideas: “Essentialist naturalism reeks of theology—the sooner it is exorcised, the better.” To define nature as a pseudo-theological limit to what humans are or could be is by definition preservationist or conservative, where trespassing against a narrative of the natural has to be punished. Alyson Escalante’s Gender Nihilism: An Anti-Manifesto notices similar redemptive undertones in relation to some branches of trans* politics based on the idea that ‘we are born this way:’

The current politics of trans liberation have staked their claims on a redemptive understanding of identity. Whether through a doctor or psychologist’s diagnosis, or through personal self-affirmation in the form of a social utterance, we have come to believe that there is some internal truth to gender that we must divine [my emphasis]. (27)

This is of no interest to xenofeminism, which, replicating Haraway’s cyborg, favors bio-synthetic, technologically-assembled bodies that escape ‘natural’ identities as smoothly as zombies crawl away from both death and life. For Haraway, whose influence on xenofeminism is clear, the ‘cyborg’ is “a world without gender, which is perhaps a world with no genesis,” without an origin to be recovered. In agreement with Judith Butler, the manifesto is not only opposed to gender binaries but to all possible gender formations that stake their claim in the belief that the gender ‘we were born with,’ whatever that may be, is natural and that all we need to do is to reclaim it:

A sense of the world’s volatility and artificiality seems to have faded from contemporary queer and feminist politics, in favour of a plural but static constellation of gender identities, in whose bleak light equations of the good and the natural are stubbornly restored.

In contrast to such redemptive politics, in an interview, Lucca describes trans-artificiality as xenofeminism:
It’s not really surprising, for example, that there’s a disproportionately large overlap between computer hackers and trans people. You’re unlikely to try to hack your own endocrine system and radically rebuild yourself as a social and embodied subject if you don’t have a bit of restless radicalism in you. It’s not surprising if the same sensibility eventually has you reverse engineering software and searching for exploits.\footnote{24}

Thus recognizing how identity is used to reinforce oppression in the present, xenofeminism also wants to continually engineer ‘artificial’ identities. This might mean going against what is currently celebrated as ‘natural’ or the idea that our ‘natural’ bodies are sacred and cannot be modified through biohacking or hormone therapy. In her monograph, Hester also opposes the idea that anyone, cis or trans, should look for the truth of who they are in Mother Nature or in Facebook’s drop-down menu of 72 custom gender options. Her quarrel is with all so-called ‘original’ truths that ostensibly define us. Thus, Lady Gaga’s dictum “born this way,” referred to sarcastically in the manifesto, might be a welcome change of tune but what it affirms is still only a theological naturalism. “And God created man and woman” does not suddenly become a better sentence if we add “and seventy-two categories of the gender-nonconforming.” Andrea Long Chu makes a similar argument when she asks whether we could see transition “recast in aesthetic terms, as if transsexual women decided to transition, not to ‘confirm’ some kind of innate gender identity, but because being a man is stupid and boring.”\footnote{25}

Beyond the false correlation of ‘natural’ with ‘good’ and ‘innate,’ desire is a synthetic, it is the artifice to trump the supposed truth of God or Gaga-given identity. We would rather be engineers than goddesses.

Aside from being a poor riff on theology, the idea that identity is something to struggle towards rather than away from might make it harder to see how gender is intrinsic to the economy, not to our bodies. Reflecting on how identities relate to economy could strengthen Hester’s argument. In the commercial realm, sexed identity does not simply mean blue micro-suits for boys and pink dresses for girls. It is not just boys and girls. “Their name is Legion, for they are many,” to borrow from the highly quotable Gospel of Mark.\footnote{26} As Malcolm Harris writes, capital does not “double down” but multiplies and “splits,” it is not a bureaucratic stiffness but an ever-multiplying fluid network of porous powers that spit up identity constellations through exploitation.\footnote{27} As a ‘gender nihilist’ would add, understanding that there is no transcendent truth to identity simultaneously shows us how identity is assembled under power: “Gender, race, sexuality, and every other nor-
mative category is not referencing a truth about the body of the subject or about the soul of the subject. These categories construct the subject and the self’” [my emphasis]. Joni Pitt and Sophie Monk demonstrate how queerness is not an identity but a relation of economic marginalisation:

[We] understand queerness not only as something to pair with precarity, but queerness as precarity...Welfare cuts not only constitute deprivation, but also serve a disciplinary function: to individualise the welfare needs of the queer community into discrete cases, and exclude the possibility of collective organising and solidarity. Since the proletarian queer must individually justify their reliance upon welfare services, this intensifies the precarity of their access to welfare and forecloses the possibility of genuine ‘support’... Think also about those queer orphans expelled from the family unit. As long as their parents can be shown to have assets, housing benefit remains unavailable to the child unless they endure a long and emotionally harrowing process of documenting that they are genuinely estranged from their parents.

Xenofeminism could considerably benefit from considering how queerness is enacted by capital as an identity of economic precarity and how capitalism is a type of magical thinking or sorcery, which creates with one hand what it describes with the other. To treat identity not as a tool but as a truth is no revolutionary gesture but grist to the mill of neoliberal capitalism. As the middle-class disappears, as more people are pushed towards poverty while working longer hours without basic social services, as the proletariat turns into the ‘precariat’ that survives from one short-term contract to the next, capitalism breeds and commodifies pseudo-difference in seventy-two shades. In that, it homogenizes through difference, that is, commercial identity is carved out in ways so specific and static as to secure the proliferation of small bubbles that produce very specific advertising outcomes. On a psychological or organisational level, this translates into a promise that if we specify our search criteria diligently enough we will finally be not among strangers but friends who are like us. From this angle, the fact that xenofeminism welcomes the stranger, the unknown, “all of our alien kin,” as the manifesto says, is potentially very promising. This contingency and incompatibility should be weaponised and gamified, not rejected in favor of ‘more of the same.’

In this opposition to the stasis of sameness, Hester’s monograph goes beyond challenging how personal identities are carved out. Echoing feminist critique of
normativity, she wants to challenge the household and the nuclear family unit:

From the street to the home, domestic space too must not escape our tentacles. So profoundly ingrained, domestic space has been deemed impossible to disembed, where the home as norm has been conflated with home as fact, as an un-remakeable given. Stultifying ‘domestic realism’ has no home on our horizon.30

The success of this idea of the single family home is really quite remarkable when one considers its many limitations: it tends to be isolated, labor intensive, and energy inefficient; it’s also riven with tensions, interpersonal animosities, and power asymmetries, which are often felt particularly acutely by queer youth.31

Hester insists that the home must be reimagined because so many are already forced outside of it. Indeed, a report by the Albert Kennedy Trust in 2015 tells us that close to 70% of British LGBT youth experienced abuse from their own families. Ejected from the family structure, they compose 24% of youth homeless population. How could we insist on reproducing the home if it so often is a predatory space for women, trans* and queer people who are forced to conform to a structure that uses them as cannon fodder to its own replication? Patriarchy desires the uninterrupted reproduction of the home, the copying of mommies into wives, the replication of blissful and oblivious childhoods complete with the uneven distribution of labor that assures them. Nostalgia for the good old times pervades the hearts of those who were at the receiving end of reproductive labor but remained blind to its workings.

The family can inflict passivity and isolation—women are expected to seamlessly invest all ethical ambition and unpaid labor into their children while withdrawing from public life. Just by the possibility of being mothers, women are supposed to be a natural measure of virtuous commitment yet they are rarely allowed to participate, as mothers, in the political sphere. The manifesto urges to build alternative families and homes, not bound in the endless reproduction of this paralysis:

We see too well that reinventions of family structure and domestic life are currently only possible at the cost of either withdrawing from the economic sphere—the way of the commune—or bearing its burdens manyfold—the way of the single parent. If we want to break the inertia that has kept the moribund figure of the nuclear family unit in place, which
has stubbornly worked to isolate women from the public sphere, and men from the lives of their children, while penalizing those who stray from it, we must overhaul the material infrastructure and break the economic cycles that lock it in place.

For Hester, this means better communal infrastructure, “a renewed emphasis on community resources, collective housing, and socialized care practices [which] could offer real opportunities for restructuring social reproduction.” While on the surface these ideas read as unproblematic, xenofeminism must be wary of how the idea of the ‘commune,’ popular in the west since the 1960s, is currently re-deployed in the service of neoliberal working spaces. For example, in her article “Promethean Labors,” Hester writes approvingly of previous feminist attempts at communal living but they also sound suspiciously close to the Facebook campus 2.0:

These feminists devised various approaches to rethinking domesticity, such as collective residential neighborhoods featuring cooperative housekeeping centers and kitchen-less houses, apartment hotels with communal dining rooms and spaces for shared childcare, and courtyard housing blocks with a common laundry, parlor, and library (as well as spaces for food preparation).

The general argument is that an ‘artificial,’ that is, not normative approach to identity and family could eventually scale up to a polity but how to achieve this remains an open question. Contrary to the manifesto’s enthusiasm for large-scale thinking, Hester proposes small actions and local interventions, without explaining how exactly could they scale up or compete with neoliberal ‘community’ models. If not facilitated by supra-national corporate infrastructures, how could this transition happen without a large actor, such as the state? In the absence of such explanation, her xenofeminism implicitly embraces standard state-socialist blueprints, satisfying little of the appetite for systemic techno-political complexity that the manifesto awakens and alienating a sizeable portion of geopolitical territories that have already witnessed the failure of this model.

BEYOND SEX: XENOFEMINIST FUTURITIES

No more futureless repetition on the treadmill of capital, no more submission to the drudgery of labour, productive and reproductive alike, no more
reification of the given masked as critique. Our future requires depetrification.

Xenofeminist Manifesto

The idea of seizing technological progress to re-engineer reproduction has been enjoying popularity in recent conceptual fiction. In Louis Erdrich’s *Future Home of the Living God*, evolution runs backwards and women birth primordial species. In *XX*, a lesbian couple uses an ovum-to-ovum technology, which lets them conceive offspring without sperm. In *The Handmaid’s Tale*, now adapted as a series, seduces with its reproductive dystopia. Reproductive labor is also at the heart of Hester’s book. This concerns both social reproduction and sexual reproduction. As described by Silvia Federici, with the rise of capitalism, most reproductive work was confined to the realm of the domestic, where women reproduce the fabric of society by giving birth to the workforce, managing the household and maintaining familial bonds. By naturalising and exploiting this unwaged labor, capitalism deferred the lion’s share of its own reproduction to women, who were perceived as ‘naturally’ predisposed to it. As dismissive as society is towards these jobs, they are the necessary social glue that assures the smooth reproduction of both the workplace and the family, with women’s secretarial, administrative, emotional, and sexual work as the invisible foundation.

While absent in the monograph, in her published essays, Hester pays attention to the future of work from the perspective of the so-called ‘feminisation’ of labor, which means that work is becoming ‘naturalised’ to the extent that most of it is unpaid. It is here worth repeating that for Marx, capitalism as a historical stage that displaced feudalism is defined by the alienation of workers from the fruits of their own labor. In essence, capitalist exploitation means that an ever-smaller group of people benefits from the population’s growing productivity. In fact, inequality will expand alongside the increase in production, rather than despite of it. Unlike money, which decreases as we use it, capital breeds capital, allowing for the number of its owners to decrease and for the wealth gap to grow with time. This is precisely why Marx tells us that wealth is measured through disposable time, that is, time that multiples its own surplus and becomes truly free. Because disposable time is the measure of wealth and the wealth gap is growing, everyone but the wealthy has increasingly less free time. Ignoring Marx while repeating him, the object-oriented ontologist Ian Bogost calls this “hyperemployment,” defined by growing time-costs of maintaining our social, personal and working lives:
Pay is almost beside the point, because the real cost of hyperemployment is *time* [my emphasis]. We are doing all those [administrative] things others aren’t doing instead of all the things we are competent at doing.\(^{38}\)

Acting in a vast conspiracy that continually forces me to cite men in order to point out how incompetent they can be at literature review, Bogost gleefully neglects the body of work on that exact subject produced at least since the paradigm-setting ‘Wages for Housework’ project in the 1970s. The movement, which is of a visible influence on Hester, started in Italy and focused on how capital exploits women’s unwaged reproductive labor. Being a woman is the original hyperemployment: it is where personal, administrative, emotional, waged and unwaged labor is as necessary as it is disregarded, naturalised and derided. Women are so skilled at this work that the work itself became invisible.

This brings us to Hester’s expertise the field of labor studies, which is not represented in the book but well-worth mentioning here as a supplement to the arguments she advances. In the “Technically Female: Women, Machines, and Hyperemployment,” Hester, in dialogue with Nina Power, points out that automation has long been replacing work coded as feminine. Power recounts how the *more* that women’s disembodied voices are present in society—in interactive animated pornography, at the automated shopping checkouts, in apps, on urban transport systems—the *less* the interests of actual women are recognized in the public sphere. Hester sums up, “women’s voices have historically been used to issue instructions...precisely because women themselves have not been around [in public spaces] to be heard,” which made the sound distinct in all-male environments.\(^{39}\) Simultaneously, jobs *become* valued at the moment that machines, rather than women, perform them. All work associated with women is rendered either invisible or mocked but becomes valuable as soon as the same work is done by a machine or an app:

As feminised work becomes technologised work, it may come to be less culturally denigrated, and therefore more available to be taken up by different kinds of subjects. Those with choice and cultural capital, in other words, may be more willing to perform this labour if it is associated with culturally valued [technical] objects rather than with socially disparaged [female] subjects.\(^{40}\)
This dynamic of labelling the most necessary work as the most unworthy marks women not only in the public workspaces but also in their second office—the house. Maintaining a foetus and then bringing up a child is as necessary for the species as it is looked down on. Does this mean that as long as women have babies, “the heteronormative centre chugs on”? In the second chapter of the book, Hester ponders this question through a critical reading of Lee Edelman’s queer-fatalist refusal. It is not by accident that every mainstream dystopian film ends with the reinstatement of the nuclear family, as if imagining ecological disaster served to stir people’s libido and force them to make more babies so that the species can survive. This narrative simultaneously makes ‘infertile’ queer lives unworthy of reproducing or sustaining, leading Edelman to write, “fuck the social order and the Child in whose name we’re collectively terrorized...fuck the whole network of Symbolic relations and the future that serves as its prop.” While she sympathizes with the way Edelman refuses the violence of heterosexual futurity, Hester wants new family structures but also reproductive justice for existing mothers and children: taking care of those who do the work of reproduction, making sure that the air they breathe is clean, their children, if they want to have them, have access to healthcare and a roof over their head, that food and water of quality is available, and that sexual harassment and domestic violence are eradicated (55-65). It is on these grounds that maintaining a liveable environment is for Hester a xenofeminist goal. Too often, she is quick to point out, do environmental activists mirror paranoid guards of the ‘natural order,’ asking that the bodies of human and nonhuman animals are conserved in their present state rather than encouraged to co-evolve with and adapt to the increasingly ‘artificial’ environment (45). (Cue the famous Alex Jones meltdown about frogs becoming gay because of ‘chemicals.’)

Hester thus warns not to correlate species survival with forced heterosexuality and with the Child as the only figure that commands environmental action while at the same time excluding anyone who does not worship its dogma. The book would benefit here from engaging with contemporary ecofeminism rather than the one from three decades ago! For example, putting into dialogue the work of Rebekah Sheldon and Donna Haraway, Sophie Lewis writes that “society requires the cipher of the Child...it prefers the ‘melancholic anticipation of future loss’ to the messy response-ability of situated ‘living and dying together on a damaged earth.’” (This fallacy repeats when it comes to other animals: tearing up at the prospect of a future loss of a species while at the same time abdicating the responsibility for billions and billions of animal young living their lives under grotesque torture in factory farms.) The poster of the Child, seemingly neutral, is no friend
to queers neither to actual children. Hester criticizes celebrating “the wealthy, white ‘yummy mommy’” marching in greenwashed parades with printouts of baby faces demanding a better future, while “teenage mothers, black and Latinx parents, trans* and genderqueer subjects, immigrants, refugees, and benefits claimants” are rarely perceived as ‘the future’ that is worth fighting for (52). Indeed, as Hester notes, it is people of color, native populations and migrants who had long suffered medical racism, eugenics and forced sterilization (14); or were mandated to give up their children ‘for their own good,’ no more visibly than in the case of Australia’s Stolen Generations, or, even today when Native Canadian women are asked to agree to sterilization right after labor if they want to keep their newly-born children. Thus, Hester’s interprets Haraway’s slogan of “make kin, not babies!” as a call for “post-gender, multi-parent genetic engineering,” where bodies and families are “hospitable to otherness” (64-65) and reproductive future means something more than just the state refurbishing its ranks by cloning the nuclear family (53).

It is a shame that Hester does not engage decolonial theory, which has been pointing out the flaws of ecofeminism since the 1990s. Similarly to the manifesto, Hester paints ecofeminism as naïve, romantic or essentialist. While it may serve as a useful foil against which xenofeminist celebration of artifice can form, this risks defining ecofeminism primarily through its new age-ish, western image, ignoring politically cognizant, sharp visions of ecofeminism present in the work of indigenous scholars. For example, Laura E. Donaldson critiques Clarrisa Estes’ infamous Jungian-tribal Women Who Run with the Wolves: Myths and Stories of the Wild Woman Archetype for the misplacement of collective indigenous politics onto the terrain of individual growth for wealthy western women. Indeed, mainstream ecofeminist discourse often slips into the aesthetics of bad self-help books, where the essentialised Nature was to be utilized as a site of self-growth for women disconnected from their “roots.” Decolonial theory points out that these problems persist today and that the underlying colonial logic of environmental degradation keeps being ignored; these studies are the unacknowledged genealogy of Hester’s argument above. The move to celebrate ‘artifice’ and reject ‘nature’ can erase the work of those who have been deconstructing nature for the last few decades, often working in imperial or colonial contexts. Furthermore, while xenofeminism describes itself as a feminism of large scale and indeed has ambition to redefine not only our individual relation to our bodies but the seemingly immutable social structures, it is yet to address the fundamental question of the future, which is the ecological crisis. With its current definition of nature as simply ‘the norma-
tive,’ it appears not best-equipped to do so, a point I already made in my previous article on xenofeminism. Despite its promise to challenge the given, Hester’s xenofeminism only envisions single-species households and predominately human spaces, thus far providing no reflection on interspecies or ahuman/asocial spaces to come.

OUTRO: XENOFEMINIST TECHNOLOGIES

Why is there so little explicit, organized effort to repurpose technologies for progressive gender political ends? XF seeks to strategically deploy existing technologies to re-engineer the world.

Xenofeminist Manifesto

Xenofeminism takes cyberfeminism’s positive valuation of technological alienation seriously, it is turned on with—and by the machines, rejects originary authenticity, and has days where it wants to merge with matrix.  

Inevitably, Hester also considers the pivotal point of women’s reproductive work: pregnancy and child-rearing. The internally estranging process of having a human being grow inside one’s body should not be easily disregarded for anyone interested in the politics of strangeness and alienation—Maggie Nelson’s The Argonauts manages to capture this process of othering while at the same time breaking the seemingly immutable connection between pregnancy and the heteronormative family. Hester herself says in an interview that “the baby is the ultimate chemical weapon. It makes you feel things that you might not want to feel. Very strange to be on the receiving end of.” Despite the unfamiliarity of pregnancy and its potential to reconfigure the family unit, we often hear the opposite argument: that being a mother or wanting to become one is the most ‘natural’ thing in the world and that heteronormative family structure necessarily follows from it. Shiva and Mies celebrate submitting to this wild and uncontrollable life force by refusing reproductive technologies, and here lies Hester’s quarrel:

[For Shiva and Mies], reproductive technology offers a disenchanted alienation, achieved via devolving epistemic authority to medical experts, whilst nature offers a (for some reason vastly preferable) enchanting alienation, achieved via the subjection of the impregnated body to forces beyond its control.” (17)
Embracing ‘disenchanted’ birth control against natural contingency of conception, Hester criticizes equating pregnancy with the experience of all women, a word far too wide to encompass specifically the group of fertile cis women. Of course, under patriarchy, pregnancy has been and continues to be the bane of cis women’s oppression, given that a woman’s worth has been historically correlated with her ability to produce offspring and ensure the elongation of the family line, a fact immortalized in the still enduring tradition of naming kids after the father even though almost always it is the mother who suffers all consequences of bearing and bringing up children. Here xenofeminism departs from post-structuralist focus on discourse, echoing the return to material reality in the work of scholars such as Katerina Kolozova, whose work represents the feminist return to categories such as the real, the material or the bodily as existing independently of cultural discourse. While Hester admits that as of now, pregnancy may be a biological difference between various groups of women, xenofeminism “dispute[s] that this difference is immutable” (20). In fact, we have already been using technology to change this, most notably through in vitro. In the future, there is no reason why we should not deploy technology in the service of xeno-pregnancy, either through ectogenesis or as of yet undiscovered forms of surrogacy.

This can make one daydream well beyond Hester’s own arguments. If all human bodies could augment themselves or technologically-outsource the production of offspring, the marker of ‘womanhood’ might become largely irrelevant as a sexual identity and instead transform into a generic technology, allowing the species to extended itself through controlled artifice. Even if we were to follow the idea that because of being mothers, women are more rational (they have to both decide which genes are worth passing and which environments are good for having offspring in), that would be all the more reason to make pregnancy a technology accessible for all. If we set down this path, however, xenofeminism must remember how wealthy women’s reproductive labor, from cleaning to child-rearing, has already been outsourced to poor women, often of color or from developing regions such as Eastern Europe. In this morbid ‘solution,’ patriarchy automates its own reproduction and the only way for women to reduce their reproductive labor is to defer it to other women. We are yet to develop technologies that challenge this stasis rather than reproduce current asymmetries.

Surprisingly, rather than drawing blueprints for contemporary xenotechnologies, Hester closes the book with a lengthy case study chapter that focuses on a single object, “the Del-Em menstrual extraction device devised by American feminists in
the 1970s” (70). It is no wonder that this domestic appliance, born at the height of women’s self-help and solidarity movement, is central to a book largely informed by scholarship from Second Wave Feminism. A detailed analysis, where every bit of information matters, makes the chapter difficult to summarize but shows with clarity how Hester’s xenofeminist proposals work in action. A tool of DIY care, Del-Em has large-scale applicability (many women menstruate regardless of geopolitical standing), bypasses gatekeepers and functions within a network of communal care. Given the condescension and rejection that women have historically suffered and still suffer at the hand of the medical system, this is a fitting case study, which connects to the practices of midwives, denounces racist histories of genealogy, discusses hormone biohacking, community-created self-care guidebooks for cis and trans women, the National Black Women’s Health project and Native American health initiatives, while also reclaiming self-care from YouTube influencers and making a case for a feminist international beyond the West. In her analysis, Hester demonstrates how she understands the ‘intersectional universalism’ of xenofeminism, akin to Michelle Murphy’s ‘protocol feminism,’ “a form of feminism concerned with redrafting and distribution of techno social practices by which the care and study of sexed living-being could be conducted” (108). This is an argument for adaptability: for a protocol to work, it must be both attentive to context and translocal, in other words, it must be intersectional. In her descriptions of such everyday acts of biohacking, Hester embraces cyberfeminist legacy, stating that the Internet could facilitate a “bottom-up movement centred on self-equipment via knowledge exchange” (95).

On the one hand, Hester’s attentiveness to past feminist and queer work is admirable, her careful writing style, mindful to remain inclusive, is exemplary. It rejuvenates and makes readily relevant various feminist theories from the past few decades, giving us a lesson in picking apart problematic legacies. From this angle, it almost rejects the bravado of the manifesto, whose aesthetics are necessarily provocative, its propositions presented as novel, as if without a source. Hester, an academic, rushes to correct this, showing us that xenofeminism is in fact very aware of its debt to existing feminist work. On the other hand, the manifesto—as any manifesto—promises the new, or at least something with which to justify its urgency. It is indisputable that the matters of everyday social and bodily oppression of women, which Hester pays attention to, are as relevant as ever. Yet in the manifesto there is a promise, an allusion to the unacceptable, to bio-industrial forms growing someplace dark, where actions lose coherence and causality, a world without us. Thus far, it remains only that—a promise, a whisper
from the other side, a troubled signaling that we need something else or that we begin to perceive a challenge of a scale not seen before, humming somewhere alongside our digital axes, across our machines, our plants, our bodies, ourselves. Hester’s monograph gives us a necessary foundation of xenofeminism—a caring, down to earth assessment of every feminism’s obligation to its roots. This type of genealogical work is the first step of every feminist praxis. But from the future arrives something else, it may even be a crisis that effortlessly drills holes in our fabrics of sense, action, temporality. Extinction, automation and cunning autonomous intelligences that remain to be detected already wrap themselves around our bodies, families, states and planets. Nowhere to be found in the monograph, the promised xenofeminist vision of “unprecedented cunning” and scale is still to come.

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NOTES

18. Ibid.
21. For example, Judith Butler, *Gender Trouble: Feminism and the Subversion of Identity*. Abingdon:


24. Hoheveen and Fraser, “Feminisms of the Future.”

25. Ibid.

26. In this epic scene, Jesus asks a possessed man how many demons currently live inside him. The man replies, “My name is legion for we are many,” before the demons are cast out and hide in a pig, which starts running manically around and then drowns itself. Mark 5:9.


30. Laboria Cuboniks, The Xenofeminist Manifesto.


33. Hester, “Promethean Labours.”


40. Ibid.


44. CBC Radio, “Indigenous women kept from seeing their newborn babies until agreeing to sterilization, says lawyer” CBC radio, November 13, 2018, https://www.cbc.ca/radio/thecurrent/the-current-for-november-13-2018-1.4902679/indigenous-women-kept-from-seeing-their-new-


48. Edia Connole and Amy Ireland, “Edia Connole Interviews Amy Ireland.”

